Managing the Fuzzy Front End

Within the Aviation Maintenance, Repair and Overhaul

TU Delft

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Designing a front-end idea evaluation framework

This Master's thesis is presented to the Delft University of Technology in partial fulfilment of the requirements to obtain the degree of Master of Science (MSc.) in Management of Technology.

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Front page picture: Rationalize

ABSTRACT

Aviation Maintenance Repair and Overhaul (MRO) organisations are facing a lack of sustainable alternatives within MRO, which could aid a more sustainable operation geared to meet short-term climate regulations. Hence, they need to establish an idea evaluation process, allowing organisations to assess and prioritise generated ideas to assess which have the potential to contribute to the industry's decarbonisation.

This research aims to determine how innovative ideas can be assessed and selected to speed up the innovation process within aviation-MRO. In particular, the Front-end of Innovation (FEI) is researched as this phase is considered extremely important within the innovation process. The FEI is the first phase of innovation, ranging from idea generation to concept development.

This study utilised a mixed method approach to achieve the research objective, in which multiple methodologies are synthesised into one more extensive study. Firstly, extensive literature research was performed to determine the evaluation models applied within the existing literature. Next, industry-specific interviews were conducted to acquire standard practices within the aviation MRO. Thirdly, survey research was employed to tailor the idea evaluation model toward the aviation MRO industry. Finally, a case study was performed to determine whether the proposed case study could be applied within the organisational context.

The framework incorporates a stage-gate process, incorporating two evaluation moments named the initial screen and the preliminary evaluation. The first evaluation includes a checklist with five criteria, followed by an evaluation matrix incorporating fourteen criteria. Although the framework serves as the basis for the idea evaluation process, the case study revealed that there is no one-size-fits-all process. The organisation context impacts the evaluation criteria, meaning each organisation should individually assess which of the proposed criteria are deemed relevant within their organisation.

The framework proposed in this research provides a structure and tools to organise the idea evaluation process, which can aid organisations in enhancing the speed of the innovation process potentially. On this basis, the proposed framework can be utilised by aviation MRO organisations to accommodate the foundation of the idea evaluation process.

ACKNOWLEDGEMENTS

"The value of an idea lies in the using of it" – Thomas A. Edison

Five months ago, I started the final phase of my educational trajectory to pursue my Master of Science. I was unaware of the challenges yet to come; however, I was certainly committed to this research as it allowed me to combine my BSc in Aviation Engineering and my "to be obtained" MSc in Management of Technology. In hindsight, the thesis trajectory was an intense learning experience. I improved my skillset in multiple facets, ranging from performing an extensive scientific literature review to establishing contact with industry parties. Nevertheless, I would like to express my gratitude to everyone who helped me during my graduation and a few people in particular.

First and foremost, I would like to sincerely thank my university and company supervisor for allowing me to pursue my graduation track and the associated master's degree. I would like to thank R.M. Verburg (TU Delft) for the excellent feedback and support throughout the process. In particular, his various points of view were vital for me to keep on track and progress in the right direction. I would like to express a word of gratitude to the KLM supervisor as she provided me with the opportunity to perform a case study within KLM Engineering & Maintenance to test and improve my idea evaluation framework. Without this support, I would have certainly not been able to transfer the framework into an operational process.

Secondly, I would like to thank all the interviewees and respondents that participated and contributed to this research. Without the crucial industry-specific information, I would not have been able to steer my framework towards the Maintenance, Repair and & Overhaul industry.

On a personal note, I am genuinely grateful for all my family and friends who supported me through this challenging five-month period. They have always expressed their legitimate interests and thoughtful support to ensure I could create this finalised MSc thesis.

I hope you enjoy reading my thesis,

Sincerely yours,

Danny Lemmen

Amsterdam, 05 August 2022

Glossary

Front-end Innovation	The first phase of the innovation process is initiated when an opportunity is identified within the organisation and ends when the idea is approved and selected to be turned into a concept (Eling & Herstatt, 2017).
Innovation process	A multi-stage process aiming to convert ideas into new/improved processes, products and services to differentiate organisations effectively within the marketplace (Baregheh et al., 2009).

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AFI	Air France Industries
E&M	Engineering and Maintenance
FEI	Front-end Innovation
IM	Innovation Management
KLM	KLM Royal Dutch Airlines
MRO	Maintenance Repair and Overhaul
NCD	New Concept Development
NPD	New Product Development
OEM	Original Equipment Manufacturer
R&D	Research and Development
SDG	Sustainable Development Goal

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1. INTRODUCTION

This introduction section will describe background information for carrying out this research regarding the idea evaluation process of Innovation Management (IM). The section starts with the research motivation (**1.1**), where the pressure on the aviation industry is explained, resulting in an urge to innovate. Subsequently, the practical problem (**1.2**) is elaborated to reveal the underlying matter. Moreover, the research objectives (**1.3**) and questions (**1.4**) define the guidelines for this research. Next, the research methodology is described in section (**1.5**). Finally, the report structure is presented (**1.6**).

1.1. RESEARCH MOTIVATION

Climate change has emerged as one of the top priorities for modern organisations. The challenge of reducing greenhouse gasses is so complex that it currently seems unlikely that global policies can avoid a temperature rise of 2 ℃ (Azapagic & Perdan, 2011) As the aviation industry is anticipated to continue growing in the upcoming decades, on average 4.5% annually, the industry's impact will increase over time Click or tap here to enter text.(Grewe et al., 2021; Lai et al., 2022).

From 1970 until 2014, the fuel consumption of the aviation industry was annually reduced by 1.3%, on average (despite the increasing demand for air travel). These improvements came from various innovations, such as improved airframe aerodynamics, more efficient engines, weight reductions, and different materials. Without any additional future measures, the reduction of fuel consumption, and the emissions of the entire industry, are expected to reduce at the same rate during the coming decades, which is not sufficient to fulfil the objectives of the climate agreement (Bows-Larkin et al., 2016; Grewe et al., 2021).

One of the main challenges within the aviation industry, which makes it one of the most complex sectors to accomplish CO_2 reductions, lies in the absence of technological changes in the short term (Grewe et al., 2021; Ryley et al., 2020). Although upcoming technologies are promising for the industry's future, such as alternative aviation fuels and novel aircraft designs, today's challenge is that these innovations are unlikely to aid short-term climate targets. As aircraft must meet strict regulatory standards and are highly optimised as a package, they incorporate a lengthy and expensive design process (Bows-Larkin et al., 2016; Lai et al., 2022).

Due to these lengthy design processes and the lack of technological changes, the aviation industry needs to focus on other aspects to reduce emissions apart from the flight phase.

Therefore, Maintenance Repair and Overhaul (MRO) organisations are required to contribute to the reduction of the emissions of the sector. MRO organisations must balance climate regulations, the operational environment, and innovative practices to obtain and retain a competitive advantage within their industry. While innovating, organisations should evaluate ideas before devoting resources. Therefore, IM could contribute by providing means to assess and evaluate newly generated ideas within a company. Even though generating new creative ideas is essential, the sub-process of idea evaluation is often mentioned as extremely important and a critical process during IM (Kennel et al., 2013). Nevertheless, when focussing on the process of idea evaluation and selection, there is minimal literature focused on how newly generated ideas are assessed and what potential criteria are needed to select the ideas. Not all ideas can be realised, so promising ideas must be assessed and selected as early as possible to use the accessible resources for "high potential" projects (Messerle et al., 2013).

Whilst IM is a familiar term across most industries; organisations often focus on developing and generating innovative ideas for problems they face during the operation. Although this is an essential step, it does not guarantee that innovations will become operational or enter the market. Thus, ideas need to be evaluated and assessed by the organisation to determine whether resources will be devoted to the initiative and whether the organisation possesses the relevant knowledge and skills to develop the innovation (Eling & Herstatt, 2017; Kennel et al., 2013). If ideas are not thoroughly evaluated according to the same standards and processes, it might cause less optimal innovations to be pursued by the organisation (Kennel et al., 2013).

1.2. PROBLEM FORMULATION

The core problem is the lack of sustainable alternatives within MRO, which could aid a more sustainable operation geared to meet short-term climate regulations. Although sustainable ideas are being developed throughout the industry, organisations need to assess ideas to determine which ideas are worth pursuing. As organisations have limited time and resources, it is essential to establish an idea evaluation process, allowing organisations to assess and prioritise generated ideas to assess which have the potential to contribute to the industry's decarbonisation.

Hence, the industry continues to search for innovative ways to adjust today's operations to reduce the ecological impact of the sector. However, before potential innovations can make a difference, they must surpass a long path of uncertainty considering commercial success. Even though uncertainty is inherently connected to innovation, the industry is awaiting an evaluation framework to assist organisations throughout the front-end of innovation (Lüke et al., 2018).

As quoted by Cooper (2011): "The problem of project prioritisation encapsulates down to the absence of mechanisms or systems for prioritising, ranking, or even killing projects" There is often minimal structure, in terms of no predefined decision-makers and decision moments.

A front-end innovation framework could provide the vital structure to enable the comparison of various initiatives, provide a transparent evaluation process for the idea generators, and enhance the consistency of knowledge for the idea evaluators. As the justification of evaluative decisions requires both knowledge of the organisational environment and the product's status, evaluation criteria are vital to aid generators and evaluators in paying attention to multiple vital factors (Martinsuo & Poskela, 2011). This is enlightened by Carbonell-Foulquié et al. (2004), who state that review proficiency (i.e. market, technical, and financial criteria) is positively associated with product performance and the momentum of the innovation process.

The absence of formal processes (incorporating evaluation criteria) can result in non-ideal selection (wasting valuable time), potentially losing promising ideas, or devoting resources to idea failures (Barczak et al., 2008). Therefore, a formal innovation process is essential to aid organisational performance and assist MRO organisations in pursuing sustainable initiatives.

1.3. RESEARCH OBJECTIVE

As mentioned by Eling and Herstatt (2017), there is a need for an overarching framework to better understand the front-end of innovation (FEI) process due to the fuzziness of the concept. Soukhoroukova et al. (2012) remark that despite the importance of the FEI, it still demands improvements. Finally, Barczak et al. (2008) explicitly mention the absence of formal processes, resulting in the non-ideal selection (wasting valuable time), and potentially losing promising ideas. As the aviation industry is desperately looking for more sustainable practices, the newly proposed framework aims to accelerate the idea evaluation in the following ways (Ellwood et al., 2017; Martinsuo & Poskela, 2011).

- Creating a more transparent process for the idea generators stimulates them to pay more attention to already evaluated issues when suggesting new ideas. This could avoid the repetition of tasks when previous ideas are visible to idea generators and the evaluation criteria are understood and known.
- Designing a more structured idea evaluation process for the evaluators, ensuring they understand how to evaluate ideas and whom to contact for appropriate expertise. This could potentially shrink the time of completing the evaluation moments

To conclude, the aviation-MRO industry could benefit from a framework that provides an overview of the FEI phase of innovation, explicitly focused on the idea evaluation and selection process. Therefore, this research aims to establish a framework that can serve as a foundation for the idea evaluation process (as part of the FEI) within the aviation-MRO.

1.4. RESEARCH QUESTIONS

The leading research question of this thesis demands to answer the objective described above and is supported by multiple sub-questions. The central research question is defined as:

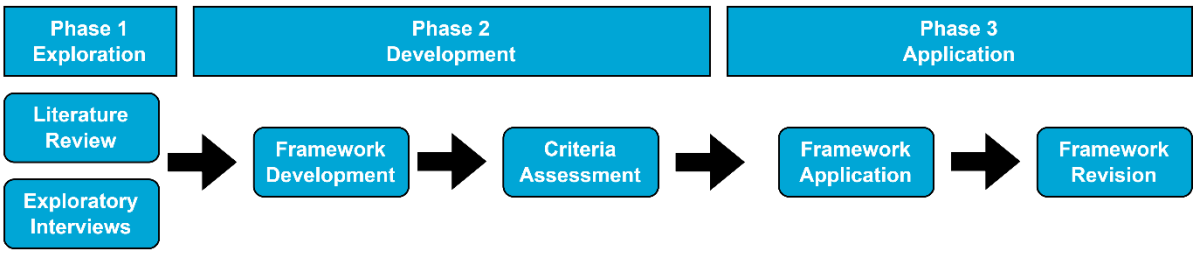
How can innovative ideas be assessed and selected by aviation-Maintenance Repair and Overhaul firms to speed up the overall innovation process?

The following sub-questions are derived to assist in answering the main research question:

1. What entails the idea evaluation process, including broader concepts such as IM and FEI?
2. What existing idea evaluation models, including criteria, are currently used?
3. What is the ideal framework for idea evaluation, adapted for the aviation MRO?
4. How can the ideal framework be applied within the aviation MRO?

1.5. RESEARCH METHODS

This research utilised a mixed methods approach, incorporating three phases discussed in the associated section of this research. During the so-called exploration phase, shown in sections



(**2 & 3**), an extensive literature review, combined with exploratory interviews, is utilised to create a foundation for the framework. Next, the idea evaluation framework is designed within the development phase, presented in section (**4**), and industry experts assess the criteria. Afterwards, as described in section (**5**), the framework is applied within KLM E&M and evaluated within the organisational boundaries (Figure 1).

Figure 1: Research Phases

1.6. REPORT STRUCTURE

The main body of this report starts with an extensive literature review to enhance the understanding of the overarching concepts and identify the generic idea evaluation process and

selection criteria utilised within the literature (Section 2). Secondly, industry insights are obtained to determine how they have organised the idea evaluation process. Furthermore, additional criteria are described that are not mentioned in the literature (Section 3). Subsequently, the literature and the industry insights are combined to design an idea evaluation framework tailored to aid Aviation Maintenance Repair and Overhaul (MRO). This framework can be a foundation for the idea evaluation process (Section 4). Finally, a case study is performed to apply the framework within the KLM's organisational context, aiming to evaluate its applicability and determine improvement points (Section 5). The main body of this research study is visualised in Figure 2. Hyperlinks are added for quick excess to specific sections.

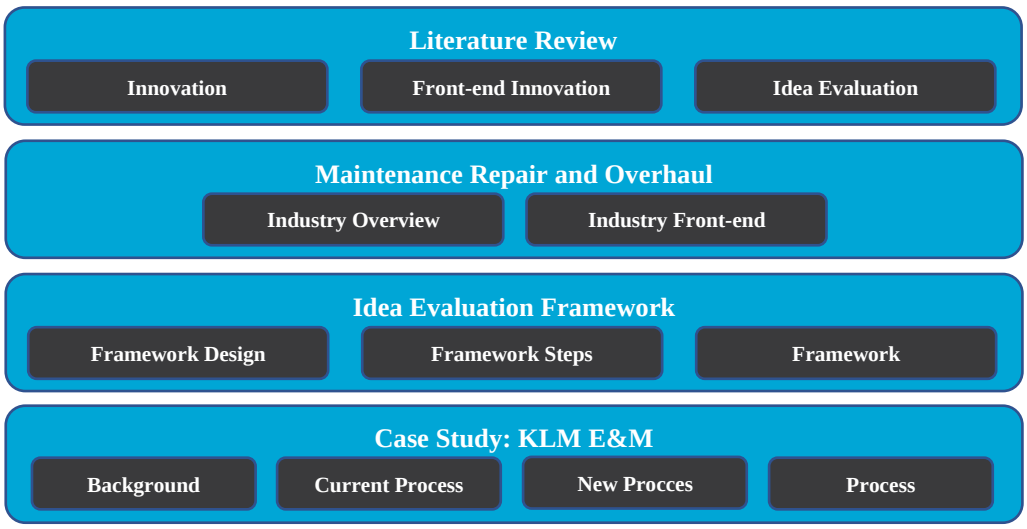


Figure 2: Report Layout

2. LITERATURE REVIEW

Within this section, an exhaustive and systematic literature review was performed. By utilising this approach, this literature review aimed to answer the following sub-questions:

SQ1: What entails the idea evaluation process, including broader concepts such as IM and FEI?

SQ2: What existing idea evaluation models, including criteria, are currently used?

The first research question will be answered entirely throughout this section, as an enhanced understanding of the concepts is provided in the first parts of this section. The second sub-research question is partially answered throughout this section, as the existing models in the literature are explored. However, exploratory interviews are conducted in the next section to discover idea evaluation practices within the aviation-MRO industry, as this is barely described in the literature.

Firstly, an overview of the crucial concepts was created to gain insight into the research area. Relevant research keywords and scientific databases were identified (Table 1). Scopus, Science Direct, and Google Scholar were utilised to collect the appropriate literature. Additionally, the International Journal of Innovative Management, European Journal of Innovative Management, and Journal of Industrial Management Perspective were separately examined to ensure that articles not included in the databases were also considered in this literature review. Apart from the direct search of papers in both databases and specific journals, the snowballing methodology was used to identify relevant sources with the help of references and citations within papers.

Table 1: Research Keywords

Topic	Alternative keywords
Innovation Management	"New Product Development",
Front-end Innovation	"Discovery Stage", "Fuzzy Front-end", "The early stage"
Idea Evaluation	"Idea Assessment", "Idea Selection"

Afterwards, this literature review established search terms as a starting point. The search terms can be found in Table 2.

Table 2: Search Terms

Sub-Section	Search terms
Innovation Management	"Innovation AND Types OR Degrees", "Product AND Process AND Innovation", and "Radical AND Incremental AND Innovation".
Front-end Innovation/ Idea Evaluation	"Idea Evaluation AND Innovation", "Innovation Management AND Idea Evaluation", "Front-end Innovation OR Fuzzy front-end".

After the relevant sources were identified with the help of the search terms described above, inclusion and exclusion criteria were defined (Table 3). Besides journals and other scientific documentation, books were examined within this section to understand the general concepts.

Table 3: Exclusion and Inclusion Requirements Innovation Management

Criterion	Exclusion	Inclusion
Source Type	Blogs, News items	Journals, Books, PhD Thesis (if based on scientific documentation)
Language	All, apart from English	English
Peer Review	Non-reviewed sources	Reviewed sources
Date	N.A.	N.A.

This literature review is arranged into three main sections and utilises a broad-to-specific approach. As shown in Figure 3, the first section (2.1) introduces the concept of innovation management, including the exact definition and the types and degrees. Subsequently, the concept of front-end innovation (2.2) is presented, where the process and dynamics are extensively explained. Finally, the idea evaluation process (0) entails different screening methods and criteria.

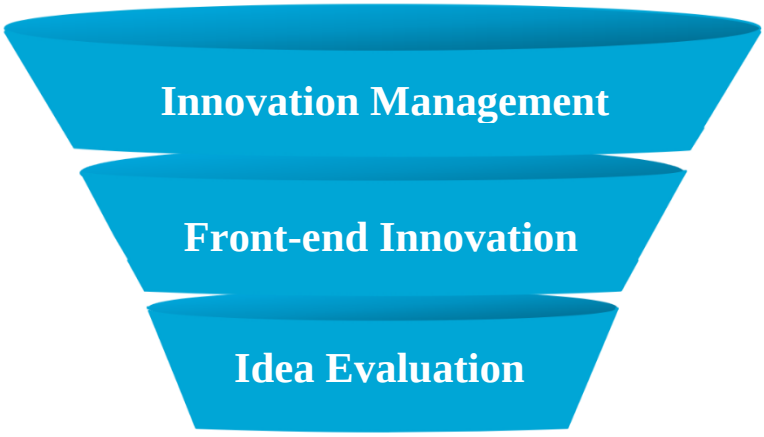


Figure 3: Report Structure

2.1. INNOVATION MANAGEMENT

The innovation process contains several phases that transform an idea or invention into a project. According to Cooper (1983; 1988), new product development generally includes a seven-step process, as displayed in Figure 4 (Cooper, 1983). Although it may seem chronological, some ideas might be revised multiple times before moving into the concept phase (Goffin & Mitchell, 2017). It is essential to note that the first three phases of the New Product Development (NPD) process are described in more detail in the latter parts of this literature review, as these phases are the most relevant for this research.

Figure 4: New Product Development Process

1. **Idea:** This stage includes generating ideas from various sources, such as market signals, competitor behaviour, and employee brainstorming sessions (van den Ende, 2021).
2. **Preliminary Assessment:** Throughout this phase, ideas are evaluated based on the idea's feasibility, utilising market- and technical assessments.
3. **Business Case/Concept Definition:** The idea is developed into a concept by detailedly defining the idea and the strategy.
4. **Development:** The actual NPD process starts at this phase. More resources in the form of Research and Development (R&D) and person-hours are dedicated to the concept.
5. **Testing:** This phase entails evaluating the product features and design, aiming to identify potential design flaws or required modifications to meet the customer's demand.
6. **Trial:** Although this phase sounds similar to the previous one, it is more focused on the commercial facets of the project, such as manufacturing and marketing.
7. **Launch:** This step includes the start of commercial production and the implementation of the marketing plan (Robbins & O'gorman, 2014).

2.1.1. DEFINITION OF INNOVATION MANAGEMENT

Afore this research can enhance the idea evaluation process; it is essential to understand the concept of IM. The concept consists of the two elements of "innovation" and "Management". There are many definitions for innovation: (1) a new service, process or technology that intends to improve organisational and individual performance (Lobo & Samaranayake, 2020), (2) the process of involving changes for practical applications (Ratten et al., 2017), and (3) the

application of products and processes new to the organisation, designed to benefit the organisation and its stakeholders (Baregheh et al., 2009).

Although definitions can vary slightly, the process of innovation, as defined by Baregheh et al. (2009), can be described as "*A multi-stage process aiming to convert ideas into new/improved processes, products and services, to differentiate organisations effectively within the marketplace*".

The second element, management, refers to managing a task and associated activities to achieve a predetermined target. By combining both aspects, IM can be defined as *"the organisation and governance of the innovation process"* adapted from (Ortt & van der Duin, 2008). Although the process of innovation is multifaceted, organisations need to sustain their competitive advantage. In this competitive environment, innovation is crucial for organisations to obtain and sustain market share to increase profitability (Ratten et al., 2017; van den Ende, 2021).

2.1.2. INNOVATION MANAGEMENT TYPES AND DEGREES

When considering the definition of innovation as aforementioned, one can define two types: product and process innovation. Additionally, the degree of newness, often referred to as the degree of change, includes four categories, as visualised in Figure 5.

As the name suggests, *product innovation* refers to developing a new product for the organisation or the market. Introducing new or further developed products can be used by an organisation to differentiate from competitors, aiming to improve the firm's performance (Huang & Rice, 2012; Newell et al., 2019). *Process innovation* refers to the development of a new way of producing products. Often organisations aim to advance current ways of managing organisational processes to enhance production efficiently (Newell et al., 2019).

Usually, product innovation requires process innovation to accompany the developed product (Huang & Rice, 2012). Even though both innovation types refer to different aspects, process innovation refers to *how* products are manufactured, and product innovation focuses on *What* is produced. Despite the different aims of both innovations, the concepts are intertwined.

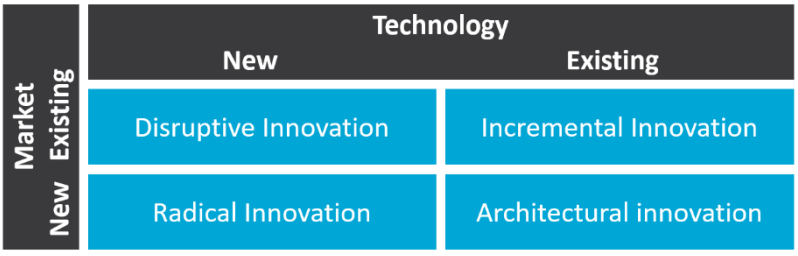


Figure 5: Innovation Degree of Change

As is visualised in Figure 5, there are four types of innovation based on the dimensions of technological change and the market environment.

Incremental innovations are adjustments to existing products and processes. These innovations continue to build upon what has been done before and aim to target the market's core customer segment. Incremental innovations are often identified through the customer preferences present in the core market. Although this type of innovation is merely adjusting products or processes, it can be essential for organisations to remain competitive in the market (Goffin & Mitchell, 2017; Huang & Rice, 2012). Some incremental innovations within the aviation industry are the introduction of flaps and slats, the design of single-spar aircraft, and the streamlined aeroplane shape (WIPO, 2015).

Radical innovations are the so-called 'Game changers', which can entirely reshape markets and create new opportunities for organisations. Organisations respond to problems in a completely new way by introducing new technologies in new markets (Goffin & Mitchell, 2017; Hoonsopon & Puriwat, 2021). One example of radical innovation is the first aeroplane, as this new technology generated an entirely new way of transportation and, therefore, a new industry. Persuing radical innovation is a risky, lengthy and costly process. Therefore, traditional evaluation systems are more applicable to incremental compared to radical innovations, as a failure to pass the evaluation process is otherwise unavoidable (Rice et al., 2002) .

Disruptive innovation means organisations are introducing new technologies to an existing market. New technologies previously dedicated to a more-skilled market are typically accessible to new markets. This change disrupts the market by displacing established vital players and creating an opportunity for other players to join. One example of disruptive innovation is the introduction of big data, which allows manufacturers and airliners to introduce predictive maintenance practices to enhance organisational performance (Zonta et al., 2020).

Architectural innovation occurs when existing technology is utilised to create new markets. By developing architectural innovations, organisations gain access to new customers who cannot use that specific technology in the new market (Kennedy, 2020). One architectural innovation is the development of business jets, featuring limited modular changes (applying existing technology), which were focused on an entirely new market of high-class passengers (Vértesy, 2017).

2.2. FRONT-END INNOVATION

As mentioned in this research, organisations have been increasing their attention towards innovation management, intending to enhance their competitive advantage within the industry. Although the FEI can be seen as one of the three essential elements of the innovation process, this aspect is often unobserved and not clearly understood by organisations (Barczak et al., 2008; Eling & Herstatt, 2017; Soukhoroukova et al., 2012).

The general concept of innovation management is geared towards "doing things right ", while the FEI stage is about achieving the "right things" (Markham, 2013; Pereira et al., 2020). The FEI has a variety of different terminologies that are used to address the first stage of the innovation process, such as the "idea stage" and "fuzzy front-end" (Eling & Herstatt, 2017). The FEI is named the fuzzy front-end because of the notorious levels of complexity and uncertainty within this first phase.

According to Elling and Herstatt (2017), the FEI can be defined as *"The first phase of the innovation process, which is initiated when an opportunity is identified within the organisation and ends when the idea is approved and selected to be turned into a concept".*

Multiple scholars have named the FEI the critical activity during the innovation process (Kennel et al., 2013). Cooper (1988) acknowledged that new product failures are likely to be traced back to critical flaws in the up-front steps of the innovation process. Moreover, throughout the FEI, an idea has the most significant possibility of impacting the complete innovation process and influencing the subsequent stages (Koen et al., 2001). When lousy ideas surpass the FEI, resources are invested in developing the idea, resulting in costly issues later in the process and fewer resources available for good-quality ideas (Cooper, 1988). Therefore, effective FEI management is required to improve the innovative throughput and enhance innovation management (Koen et al., 2001; Ratten et al., 2017).

As the definition of the FEI is presented above, the remaining part of this section presents the process of the FEI (**2.2.1**), including the various stages. Subsequently, the dynamics of the FEI (**2.2.2**) are presented to understand the inherent conflict between formalisation and creativity throughout the innovation process. Finally, the acceleration of the FEI is presented (**2.2.3**).

2.2.1. THE PROCESS OF THE FRONT-END OF INNOVATION

The FEI is the first part of the NPD process, as defined by Cooper (1983; 1988). As is visualised in Figure 6, there are three crucial aspects of the FEI: *Idea generation, Idea evaluation,* and *Idea Selection.*

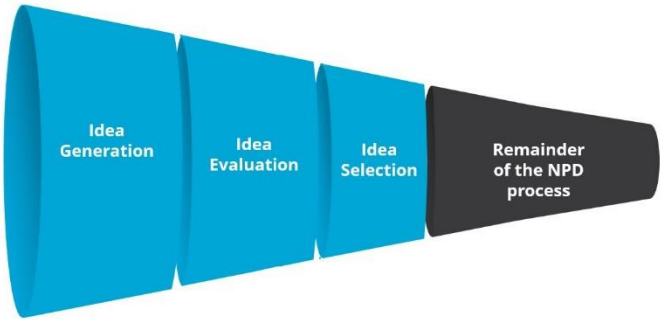


Figure 6: Front-end of Innovation

The first aspect is called *idea identification/generation* and is used to discover new opportunities. These opportunities can arise from existing problems and new knowledge from outside the organisation. Companies can also stimulate the generation of ideas through creativity sessions (e.g. brainstorming) or by organising contests (Cooper, 1988).

The second stage is *idea evaluation*, where technical and business aspects are assessed to determine if specific ideas are suitable for further development. Furthermore, a preliminary assessment determines whether the market is suitable for this idea, including customer demand.

The final stage is *idea selection* which includes selecting suitable ideas and creating a more detailed business case around the selected ideas (Hoonsopon & Puriwat, 2021; Koen et al., 2014). As pointed out in section (**2.1)**, during the FEI, innovations are referred to as ideas because they are still very premature. During the next phase of the innovation process, ideas are transformed into concepts to become projects eventually.

2.2.2. THE DYNAMICS OF THE FRONT-END OF INNOVATION

Though, it is a tricky task for organisations to manage FEI due to the complexity and levels of uncertainty (Hoonsopon & Puriwat, 2021). Increasing the formalisation of the process can result in a more manageable process for organisations. However, it can also reduce the creativity and flexibility of the process, which is essential for innovative throughput (Aagaard, 2015). For instance, Christensen et al. (2010) stipulate that using stage-gate decision moments can exclude innovative ideas that start with an initial small market (e.g. disruptive innovations usually take longer to develop, which means that in the stage-gate approach, disruptive innovations stand

no change against incremental innovations). Although the process definition might seem relatively straightforward, it is incredibly tricky to define the criteria for each gate. Organisations need to carefully define criteria to balance type I errors ("Reject a potentially good idea") with type II errors ("failing to reject a potential failure"). A powerless evaluation process results in too many projects passing the gate, meaning organisational resources are devoted to potential failures. On the other hand, stringent criteria can result in very few ideas surpassing the gate, resulting in reduced innovative throughput.

As the FEI is challenging to organise and manage, most organisations have no or inadequate management processes to deal with innovative initiatives and the organisational resources required to support innovative ideas (Hoonsopon & Puriwat, 2021). There is an inherent conflict between formalisation and creativity (Gaubinger et al., 2015). Although the FEI includes high levels of uncertainty, managing and structuring this process signifies one of the vital factors associated with innovation success (Gaubinger et al., 2015). This process includes establishing a well-described and transparent process to create a shared understanding and enhance communication within the company.

Additionally, organisations need to energise the FEI process to speed up the complete innovation process and the separate evaluated project. The key drivers to energise the FEI are: process, culture, tools, networks, systems, and strategy (Gassmann & Schweitzer, 2013).

To conclude, the FEI is an essential aspect of the innovation process; however, the literature reveals that the biggest problem lies neither in the idea generation nor the idea selection but in the process that links both aspects (idea evaluation). Therefore, an effective process is required to select the best ideas and carefully commit organisational resources to these ideas. This process should be supported by tools that can assist in selecting ideas. However, they should be guided by the general process instead of being utilised as a stand-alone. The underlying process remains essential to ensure innovative projects are balanced within the organisation and match the company's strategy (Goffin & Mitchell, 2017).

2.2.3. THE ACCELERATION OF THE FRONT-END INNOVATION

The ability to create and launch more sustainable practices within the aviation industry is critical in ensuring a sustainable business model and existence within the industry. Therefore, organisations aim to enhance innovative throughput by accelerating the complete innovation process. Hence, innovation speed is defined as the total time between the idea generation and the idea implementation into the organisation and or marketplace (Kessler & Bierly, 2002).

Previous literature stipulates that project management techniques are often applied to enhance the innovation journey. This means that a higher innovation throughput can be achieved by (a combination of) (1) reducing the completion time of a task, (2) performing tasks in parallel, (3) eliminating waiting time between tasks, or (4) avoiding repeating tasks. Although some scholars acknowledge that innovation processes are non-linear and complex, most assume that the management techniques described above are satisfactory solutions (Ellwood et al., 2017).

There are various benefits of enhancing the speed of the innovation process, as described in the literature. Firstly, higher innovation speed allows organisations to react to changes in the market dynamics and gain an advantage over the competitors. Secondly, lower development costs can be achieved when formal and streamlined processes are defined to reduce the slack within the complete process (Kessler & Bierly, 2002).

2.3. IDEA EVALUATION

This section consists of three elements. Firstly, multiple idea evaluation process models (**2.3.1**) are presented to understand the basic structure of the evaluation process. Secondly, different screening methodologies (**2.3.2**) are presented to understand the variety of options better. Lastly, the selection criteria (**2.3.3**) for both FEI evaluation moments are presented.

2.3.1. IDEA EVALUATION PROCESS MODELS

This section incorporates three idea evaluation models that originate from the literature. These models are (1) the Stage-gate model, (2) New Concept Development, and (3) Integrative Front-end Process Model.

Stage-gate model

Kim & Wilemon (2002) and Cooper (2011; 1988) stated that idea evaluation typically includes two evaluation moments. As visualised in Figure 7, both evaluation gates serve different purposes within the FEI process (Cooper, 1988).

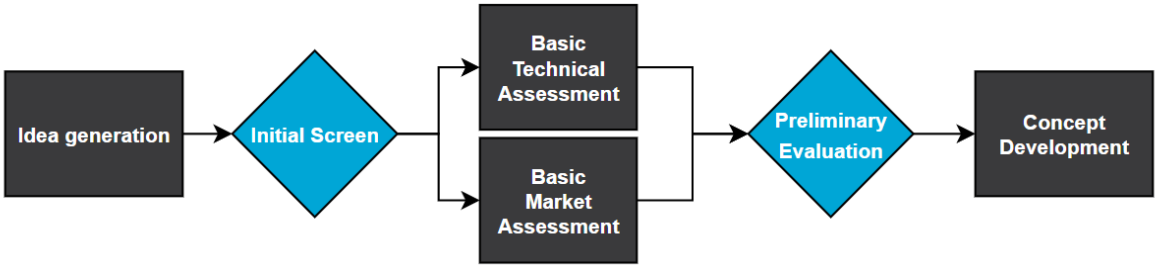


Figure 7: Idea Evaluation Process

The first evaluation moment, the *Initial Screening*, serves as a first decision moment to approve or kill innovative ideas. This gate is often called "soft" screening, where essential (must-meet) criteria are defined to evaluate ideas. The initial screen determines whether an idea is admitted to the idea evaluation phase and whether resources are devoted to developing the idea. As there are high levels of uncertainty during this evaluation moment, one can mention that this evaluation is intended to kill prominent misfit projects.

The second evaluation moment, the *Preliminary Evaluation*, is based on a fundamental analysis of the idea's technical and market potential. When this idea passes this gate, it will be developed into a concept, and a business case should be developed, which requires significantly more organisational resources. There is considerably more information in the business case, resulting in a qualitative and preliminary financial assessment at the gate.

The stage-gate model has been adapted over the years. Initially, this model introduced a sharp distinction between the stages, including evaluation criteria such as "is the project on budget/time?". The project could continue if the answer were yes, even if the business case was claptrap. This changed at the introduction of the third generation, as sharper decision points, with clear go/kill criteria, should be defined. Additionally, the model revised its distinct and chronological structure into a more fluid and dynamic one, as activities could run parallel to enable shorter cycle times. This evolved the model from a bureaucratic book of rules into a roadmap. Though, this change also incorporates a trade-off between a loss of structure due to the increased flexibility of the model. Therefore, it also increases the chances of a type II error (failing to reject failures)(Cooper, 1983, 1988, 1994, 2010).

New Concept Development

The New Concept Development (NCD) model, defined by Koen et al. (2002), provides a relationship model alternative to a linear process. Therefore, it aims to define the critical components of the FEI and create a mutual language throughout the process. As is visualised in Figure 8 (Schygge, 2015), the left side of the figure can be split up into three elements, namely (1) engine, (2) Front end Element, and (3) influential factors.

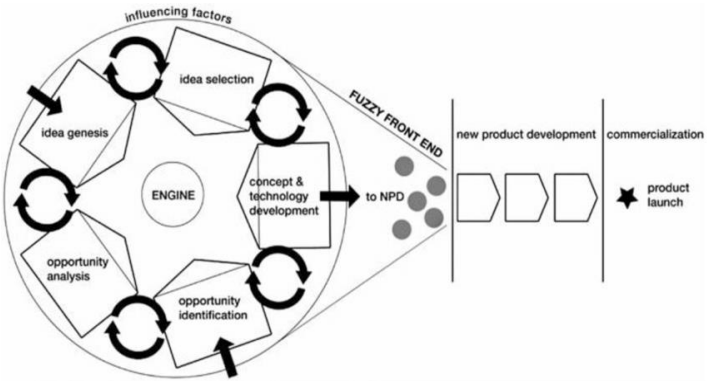


Figure 8: New Concept Development Model

This model significantly differs from the stage-gate model. Its design allows it to carry out various front-end elements in arbitrary order, as no predetermined path or sequence must be followed. However, when considering the idea selection element, this model provides no specific guidelines or elements (Belliveau et al., 2002). The advantages of this model are a flexible approach (Radical VS Incremental). However, the abstraction of the model makes it extremely difficult to transfer into the business context (Gaubinger et al., 2015).

The model provides a generic overview of a typical idea selection process (Figure 9). Koen et al. (2002) suggested that the process starts with an individual assessment, where an individual

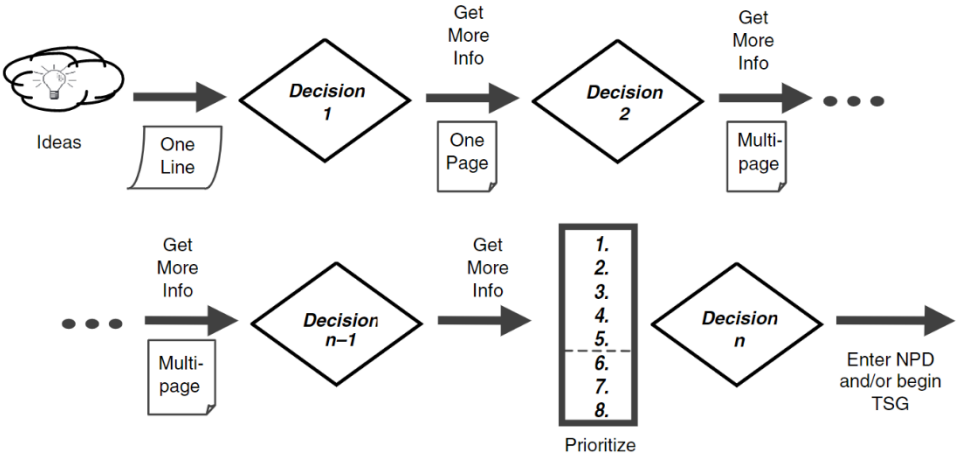


Figure 9: Idea Evaluation according to New Concept Development Model

assessment of the idea is the initial part of the selection process. It is mentioned explicitly that a transparent process is required to ensure that employees know the idea's status and remain motivated to define new ideas. In addition, it is mentioned that a formal decision process for dividing business resources is required to ensure ideas are not lost throughout the NCD process.

As an additional step, this model proposes that the process continues with a form of evaluation whereby a person or group evaluates a very early stage idea. Subsequently, more evaluation stages might be required to assess ideas before significant resources can be devoted to the idea. Although it is mentioned that "In many cases, the total number of decisions may be lowered to two" (Koen et al., 2002), Once ideas are selected, they should be prioritised to select the best ideas. Prioritisation is essential as organisations might have more ideas passing the evaluation stage, while their resources do not allow them to pursue all ideas.

Integrative Front-end Process Model

As proposed by Sandmeier et al. (2004), the integrative front-end process model is a newly-structured methodology for the FEI of the innovation process. The essence of the model is to introduce iterative learning cycles for product stakeholders and establish a guide for ensuring the comprehensiveness of the FEI activities. The model incorporates three phases, namely (1) *market and technology opportunity identification*, (2) *product and business idea development*, and (3) *product concept phase*. The first phase concentrates on the market and technological opportunities, where the goals and strategies of the organisation are the core of this phase. Throughout this phase, multiple opportunities and research areas are revealed, of which one of two should reach phase 2. Therefore, the second phase involves generating ideas within predefined opportunities or research areas. Accordingly, the generated ideas are preselected using an idea screen based on the description. At the end of this phase, a balanced product card is designed and assessed with the help of the idea selection process. The final and third phase incorporates the transformation of the idea into a business plan and concept. As can be seen in Figure 10 (Gaubinger et al., 2015), there are three evaluation stages defined within this model:

1. **Opportunity Selection:** One of two research areas is defined as a focus of the innovation process.
2. **Idea Selection (Screen):** Individual ideas are assessed based on their description.
3. **Idea Selection:** an extensive idea selection based on the formatted balanced product card.

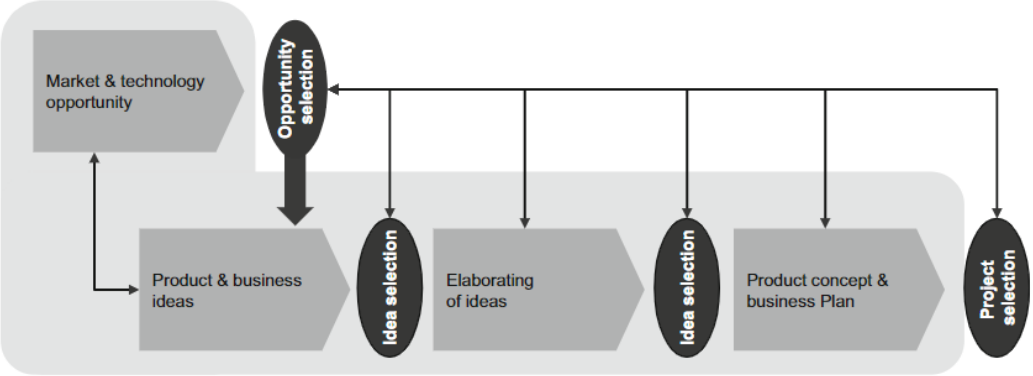


Figure 10: Integrative Front-end Process Model

2.3.2. SCREENING METHODOLOGY

Although some tools can assist companies throughout the FEI process, organisations often assess ideas without a proper process. Examining the models described above, all three utilise the approach of a multi-screen process, where ideas first need to surpass a coarser screen, which includes some criteria, although those are not very strict. Subsequently, ideas are further developed with some resources and are subjected to a more delicate screen. The advantage of this approach is that obvious misfits can be filtered out so that the second screening consumes fewer resources (Rochford, 1991).

Once the screening methodology is established, in terms of the number of evaluation moments, selection criteria should be designed to weigh the innovative ideas against them. Subsequently, each criterion should be assigned a specific weight to prioritise the ideas once the evaluation process is completed. The evaluation process incorporates multiple evaluation moments, making it essential to divide the criteria over the evaluation moments.

As the FEI in general and especially the early evaluation moments are inherently connected to uncertainty, qualitative assessment methods (including associated qualitative assessment criteria) are utilised. Especially since quantitative methodologies require more details and, therefore, a more mature idea, which would be applicable after defining the business case (Gaubinger et al., 2015), although some researchers criticise the lack of subjective screening by utilising qualitative tools, expert opinions are the only data available early in the process (Rochford, 1991). Some qualitative tools available are:

- **Checklists:** a predetermined set of criteria or questions that provide the essentials for systematically evaluating ideas. This methodology is typically utilised to filter a large number of ideas. The mandatory evaluation criteria could provide a solid foundation for the initial assessment.

- **Weighted Scores:** This tool prioritises ideas based on the weight of the criteria and the score given by the evaluator. One example is the Six Sigma Prioritisation matrix.

Within organisations, an expert review is utilised to complete the preselected evaluation methodology and assess whether the criteria are fulfilled. The expert group usually consists of the innovation manager and multiple supervisors of functional units, such as product management or R&D.

2.3.3. EVALUATION CRITERIA

According to (Rochford, 1991), the first step in the screening process is to define appropriate criteria to evaluate ideas. The criteria should be defined before ideas are generated to create a clear overview of how generated ideas will be assessed throughout the two evaluation moments.

Initial Screen

Various literature sources are consulted to determine the initial screening criteria. The following criteria are deemed relevant for the initial screen (Table 4).

Table 4: Initial Screen Criteria

Keyword	Literature
Strategic Fit	(Carbonell-Foulquié et al., 2004; Cooper, 1983, 1988; Kim & Wilemon, 2002; Rochford, 1991)
Market Potential	(Cooper, 1983, 1988; Kim & Wilemon, 2002)
(Preliminary) Feasibility	(Carbonell-Foulquié et al., 2004; Cooper, 1983, 1988; Rochford, 1991)

As Kim & Wilemon (2002) noticed, a distinction can be made between the initial screen and the subsequent idea evaluation. They found that strategic fit and market potential are especially relevant to the initial screen, whilst profitability, feasibility, resources, and competitive reactions are deemed more relevant for the second evaluation. In addition, Carbonell-Foulquié et al. (2004) revealed that, according to their study, strategic criteria, technical feasibility, and customer acceptance needed to be assessed throughout the initial screen. Succeeding, Rochford (1991) also stipulated the importance of separation of evaluation criteria, as the research presents two critical questions (is the idea consistent with the company's objectives?, Is the idea ‘’doable’’?). Lastly, the stage-gate approach designed by Cooper (1983; 1988) mentions that ideas assessed in the initial screen should be evaluated against a strategic fit, market attractiveness, and (Preliminary) technical feasibility. Essential to note is that some criteria, when possible, are submerged into common terminology. For instance, market potential and market attractiveness are merged into market potential, including the market's attractiveness. Additionally, the critical question “is the idea doable” can relate to the idea's feasibility.

Preliminary Evaluation/ Second evaluation moment

The second idea evaluation moment, sometimes called preliminary evaluation (Stage-gate), is performed when minimal resources are already dedicated to the idea. For instance, the stage-gate proposes a technical and market analysis before this evaluation moment (R. G. Cooper, 1994), whilst the NCD shows that some resources need to be devoted before this evaluation; however, it does not specify any tasks (Koen et al., 2002).

Six articles were examined to determine which criteria were deemed relevant for the preliminary evaluation (Belliveau et al., 2002; Carbonell-Foulquié et al., 2004; Dziallas, 2020; Gaubinger et al., 2015; Messerle et al., 2013; Rochford, 1991). Additionally, some researchers only reveal categories without presenting specific requirements. For instance, Martinsuo et al. (2011) stress the importance of various categories, such as markets, resources, technology, strategy, and risks, but do not specify any criteria.

Firstly, the criteria are grouped into seven categories: market, product/process, feasibility, compatibility, time, financial, and others. This categorisation is proposed by Rochford (1991) and used as the foundation for the evaluation criteria (Table 5).

Secondly, once multiple literature resources independently mention a criterion, it is incorporated in Table 5. Although it is the first filter to determine which criteria are applicable, it also introduces the chance of missing relevant criteria. Therefore, an additional control question is added to the MRO expert survey "*Does the previous section include all relevant criteria? Or do you feel a criterion is missing? If so, please name them here*" The complete survey design and results can be found in Appendix IV: Expert Survey.

Table 5: Preliminary Evaluation Criteria

Category	Keyword	Literature
Market	Market Size	(Gaubinger et al., 2015; Rochford, 1991)
	Market Growth	(Carbonell-Foulquié et al., 2004; Gaubinger et al., 2015; Rochford, 1991)
	Market Share	(Gaubinger et al., 2015; Rochford, 1991)
	Customer Satisfaction	(Carbonell-Foulquié et al., 2004; Dziallas, 2020)
Product	Strategic fit	(Carbonell-Foulquié et al., 2004; Dziallas, 2020; Koen et al., 2002; Messerle et al., 2013; Rochford, 1991)
	Product Quality	(Carbonell-Foulquié et al., 2004; Dziallas, 2020; Gaubinger et al., 2015)
	Degree of innovation	(Dziallas, 2020; Rochford, 1991)
Feasibility	Technical Feasibility	(Dziallas, 2020; Koen et al., 2002; Messerle et al., 2013; Rochford, 1991)
	Legal Feasibility	(Gaubinger et al., 2015; Messerle et al., 2013)
Compatibility	Existing Infrastructure	(Messerle et al., 2013; Rochford, 1991)
	Synergy	(Dziallas, 2020; Messerle et al., 2013)
Time	Time to develop idea	(Gaubinger et al., 2015; Rochford, 1991)
	Time to market	(Dziallas, 2020; Gaubinger et al., 2015; Rochford, 1991)
Fiancial	Cost	(Gaubinger et al., 2015; Messerle et al., 2013; Rochford, 1991)
	Profit	(Gaubinger et al., 2015; Messerle et al., 2013; Rochford, 1991)
	Return on investment	(Carbonell-Foulquié et al., 2004; Gaubinger et al., 2015; Messerle et al., 2013)
Other	Ecological Impact	(Dziallas, 2020; Gaubinger et al., 2015)

A total of 17 criteria were deemed relevant according to the literature review. The various criteria can be found in Table 5 and Appendix I: Evaluation Criteria also presents the exact definition of the criteria to ensure they are well-understood by the evaluators. Subsequently, some criteria can be combined into common terminology, as presented below. The brackets present the alternative definitions in the literature, which are combined with the bold criteria.

For category one, "market", **market size** (volume), **market growth** (long-term sales growth), **market share** (Role for the company), and **customer satisfaction** (integrated with customer acceptance) are mentioned at least twice. For category two, "product", **strategic fit** (fit with strategy, an extension of the portfolio), **product quality**, and **degree of innovation** (product uniqueness, degree of novelty) are considered relevant based on the literature review. The next category, named "feasibility", includes only **technical feasibility** (technical success probability, is it realistic), as the financial aspect has a separate category. Category four, "Compatibility", incorporates **existing infrastructure** and **synergy**. The next category, named "time", incorporates **time to develop an idea** (duration of innovation process) and **time to market** (time to commercialise). Category six, "financial", includes **Costs** (investment), **profit** (reward), and **return on Investment** (margin rate, internal rate of return). Finally, the last category, called "other", consists of **ecological impact** (sustainability) and **legal restrictions** (legal framework).

3. MAINTENANCE REPAIR AND OVERHAUL

This section serves as the second half of the framework defined in this research. The previous section defined various generic evaluation processes and criteria based on a literature study. This section aims to reveal industry-specific processes and criteria with the help of 12 expert interviews. Therefore, this section intends to contribute to the following sub-question:

SQ2: What are the existing idea evaluation models, including criteria, that are currently used?

This section incorporates 12 semi-structured interviews to gain industry-specific insights regarding the FEI process and evaluation criteria. The advantage of utilising semi-structured interviews is the flexibility for the researcher as more enhanced questions can be asked to the respondents of the interviewee (Adhabi & Anozie, 2017; Sekaran & Bougie, 2016).

The set of guiding questions at the start of each interview is:[1]

1. How does X approach innovation?
2. What process and tools does X use to assess innovations to select the most promising ideas?
3. How does X select one (or multiple) out of several ideas?
4. How does X test business ideas with limited information or knowledge?
5. What are the essential aspects and processes when designing an idea evaluation framework?
6. How does X increase the success rate of front-end innovation projects?
7. How does X overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?

Interview Selection and Ethically

As the interview respondents need to represent the MRO industry, it is essential to ensure that various organisations covering varying characteristics are included in this research. Therefore, this research incorporated a non-probability sampling approach, specifically stratified sampling. Stratified sampling entails creating a division of a population into smaller sub-groups. This methodology allows this research to obtain a small sample of the population while best representing the entire population being studied (Sekaran & Bougie, 2016).

As a result, the four quadrants of the MRO industry, combined with the two key partners, are guaranteed to be present within the subpopulations. Afterwards, random sampling was used to select at least one respondent within the subpopulations. The selection process and list of respondents can be found in Appendix II: Framework Interviews. The interview respondents were mainly contacted through Linkedin, as this platform provides information regarding their

[1] X refers to the name of the organisation the interviewee is employeed.

current role, employed organisation, and relevant skillset (e.g. innovation related). This information was compared to the inclusion and exclusion criteria from section (3.2).

As the interaction between researcher and interviewee can create ethical repercussions, the research included the following guidelines to ensure the privacy and anonymity of the interviewees. (1) names or job descriptions of interviewees are not disclosed within this research to ensure the anonymity of the respondents. (2) All interviewees are allowed to thoroughly read the interview transcript to assess whether they agree with the collected information and ensure that no classified organisational information is used for this research.

Interview Transcription and Analysis

The type of transcription used for this report is an edited transcript, where filler words and other details are omitted as long as it does not change the meaning of the interview. To avoid misinterpretation, all interviewees are asked to carefully examine the transcript to ensure the meaning or explanations are per what the interviewees meant to express.

There are relatively few accepted guidelines for analysing qualitative data compared to quantitive data. However, Sekaran et al. (2016) state three steps in qualitative data analysis: data reduction, data display, and conclusion. The interviews aimed to determine the idea evaluation process and the associated evaluation criteria; only directly related information was used to develop the framework. Although the remainder of the interview provided the necessary context, it was not directly relevant to the framework. Subsequently, the data was visualised in Figure 13 to provide a process scheme of the idea evaluation processes within the various organisations. Finally, concluding remarks were made based on the idea evaluation processes and criteria from the 12 interviews.

The remainder of this section is structured as follows, an overview of the MRO industry (3.1) is provided better to understand the various aspects of the MRO industry. Subsequently, the supplementary industry-specific processes and criteria are presented (3.2).

3.1. INDUSTRY OVERVIEW

Historically speaking, maintenance on aircraft was usually performed by airlines, specifically to meet the demand of their fleet. However, the volume of modern aviation resulted in a separation of aircraft operation and maintenance. Therefore, independent organisations could build an organisation focused on maintenance and care for multiple operators instead of one. The larger MROs have close ties with their associated operators; however, they also strive for

commercial success by servicing other operators. Furthermore, multidisciplinary organisations focus on one or multiple facets of aircraft maintenance (Ayeni et al., 2011; Sahay, 2012).

MRO organisations directly relate to two other industry players, namely Original Equipment Manufacturers (OEMs) and customers within the aviation industry. Aeroplane and engine manufacturers are closely linked as they design the product, which is maintained by the MRO (Goncalves & Kokkolaras, 2017). Likewise, MRO Organisations provide maintenance services for their customers, usually operators. Therefore, they directly have a relationship with airlines, as they are paying customers. The two industry partners are visualised in Figure 11.

Figure 11: MRO Direct Relationships

The remainder of this section describes the five distinct aspects of an MRO organisation to enhance the general understanding of the principle of aviation MRO in section (**3.1.1**). Subsequently, the following section (**3.1.2**) creates a classification for MROs to ensure that all different types of MRO organisations are taken into account when designing the ideal idea evaluation framework.

3.1.1. ASPECTS OF AN MRO ORGANISATION

MRO can be specified as the actions aiming to restore and retain the aircraft and or components into an airworthiness condition, ensuring a safe operation for crew and passengers. This includes maintenance/repair services and administrative and supervisory tasks (Rodrigues Vieira & Loures, 2016). According to Kinnison et al. (2013), five distinct aspects of an MRO organisation are:

- *Technical Services*: This department is responsible for supplying technical support and assistance for the maintenance operation (e.g. planning, training, and engineering)
- *Aircraft Maintenance:* This facet is divided into (1) Hangar maintenance, (2) Line maintenance, and (3) Maintenance control centre.

- *Overhaul Shops*: These shops are performing maintenance on items removed from the aircraft. The components could range from engines to electronics or mechanical parts.
- *Material services:* This part of the organisation is responsible for handling the supplies and parts within the MRO organisation. (e.g. inventory management of replacement parts).
- *Maintenance program evaluation:* This final department assures the quality of the maintenance program and all units within the MRO organisation (e.g. reliability control).

3.1.2. CLASSIFICATION OF MRO ORGANISATIONS

Two aspects can classify MRO organisations, namely *Maintenance Capabilities* and *organisational structure.* An MRO can have the following capabilities (Ayeni et al., 2011) :

- *Heavy Maintenance:* the more significant maintenance involves disassembling aircraft components for detailed inspection or replacement.
- *Line Maintenance*: frequent inspections and minor maintenance to ensure the airworthiness of the aircraft.
- *Avionics:* the maintenance and overhaul of electrical components within the aircraft.
- *Engine overhaul:* This aspect includes any maintenance on aircraft engines, ranging from minor inspections to complete engine repairs.
- *Conversions and Modifications:* This included the capabilities to carry out aircraft modification and the conversion from passenger to cargo aircraft or vice versa.

Besides, MROs can also be classified based on their *organisational structure*. According to Ayeni et al. (2011) and Al-kaabi et al. (2007), there are two types of organisations.

Firstly, *independent MRO organisations* focus on performing maintenance as their core business model. Although the organisation's capabilities can vary from intradisciplinary to multidisciplinary, they are not associated with a specific airline. An example is GMF Aero Asia; although they have roots as the technical division of Garuda Indonesian Airlines, they are now an independent MRO named GMF AeroAsia (CAPA, 2022; GMF AeroAsia, 2022).

Secondly, *Airline-operated-and-owned MROs* are airlines which have their associated maintenance organisation. An example of this business model is the joint venture between KLM and AFI; they have established a separate business, maintaining their fleet and providing services to other airlines. Third-party customers represent 44% of the total revenues of the MRO, creating additional revenue independently of their fleet (Air France KLM E&M, 2022).

The two categories of *Maintenance capabilities* and *organisational structure* classify MRO organisations within the industry. The classification allows for a better overview of the entire industry instead of one specific organisation. One might suggest that large airline-operated multidisciplinary organisations have a different organisational process than small and intradisciplinary MRO. As this research aims to create a framework for the ideal idea evaluation process within the MRO industry, selecting different MRO organisations is essential to ensure that all four quadrants are represented within the population.

Figure 12: Classification of MROs

For illustrative purposes, one classification of an organisation is described in the main body. HAECO is one of the larger independent MRO organisations in terms of capacity. They offer various services and are categorised as an independent *multidisciplinary independent MRO* organisation. A detailed explanation of the companies described in Figure 12 can be found in Appendix II: MRO Organisations (HAECO, 2020).

3.2. THE FEI WITHIN THE MRO

Although the concept of open innovation is receiving increasing attention, the process of how innovation is organised is not receiving much public attention. The innovation process within organisations is often kept secret as organisations aim to enhance and create (new) capabilities. As organisations try to differentiate themselves in the market, they are often unwilling to publicly share details regarding their innovation process (Schilling, 2017).

As described above (**3.1.2**), different MRO organisations must be considered to ensure that the framework represents the MRO industry. Therefore, exploratory interviews were utilised to determine how MRO organisations have organised their innovation process, particularly the idea evaluation, and what evaluation criteria are deemed relevant according to their experience. OEMs and operators are also interviewed, as they directly relate to the MRO organisations.

Respondents Frame

The study sample is compiled by using non-probability sampling, incorporating the following inclusion and exclusion criteria (Table 6). More specifically, stratified sampling is utilised to ensure that the four quadrants of the MRO industry are present. Subsequently, random sampling was used to select at least the minimum amount required.

Finally, inclusion and exclusion criteria (Table 6) were defined to ensure the respondents were deemed relevant to participate in this research. Firstly, the respondent's function should be a management role with decision-making authority. This criterion is deemed relevant as it is a tool to gain a preliminary understanding of the employee's duties within the organisation. Secondly, the role in the evaluation process is deemed relevant to safeguard the affinity with the idea evaluation process.

Table 6: Interview Sample Inclusion and Exclusion

Criteria	Inclusion	Exclusion
Respondent Function	Managerial Role	Other Employees
Evaluation Process	Directly related	Indirectly related / not related
Time employeed at organisation	12 months>	<12 months
Time in current role	6 months>	<6 months

The following respondents (Table 7) were interviewed to understand better the idea evaluation process and criteria with the MRO. A detailed description of the selected respondents can be found in Appendix II: Framework Interviews. It is essential to note that the selected respondents above are utilised to explore the various idea evaluation processes, and criteria are used within the six subpopulations. The remainder of the section is divided into two parts. The first section (3.2.1) is focused on the process structure, and the second section (3.2.2) is centred around the evaluation criteria.

Table 7: Interviewed MRO Organisations [2]

Respondent	Organisation	Classification MRO	Function
CONFIDENTIAL	JetSupport	Independent Mulitdisiplinary	CONFIDENTIAL
	HAECO ITM	Independent Mulitdisiplinary	
	ST Engineering	Independent Mulitdisiplinary	
	Air France E&M	Airline-operated Mulitdisiplinary	
	Fokker	Independent Intradisiplinary	
	Specto	Independent Intradisiplinary	
	Epcor	Airline-operated Intradisiplinary	
	Tui NL	Airline-operated Intradisiplinary	
	Boeing Global Services	Manufacturer	
	Airbus Scale	Manufacturer	
	Airbus NL	Manufacturer	
	Transavia	Customer	

3.2.1. THE IDEA EVALUATION PROCESS

Afore the idea evaluation framework can be designed to enhance the FEI within the aviation-MRO, it is essential to examine the current processes at MRO organisations. The exploratory interviews revealed that all MRO organisations have their idea evaluation process organised differently, as shown in Figure 13. However, it is essential to note that the idea evaluation processes visualised below are not always representative of the entire organisation, as different business units or departments might have distinct processes. For instance, the interviews with Boeing, Airbus, and HAECO are all associated with a specific business unit, as found in Appendix II: MRO Organisations.

Before critically examining Figure 13, it is essential to realise that the depicted process is strictly the FEI and starts after the idea generation and ends as a business case is developed. Thus, the figure does not include an evaluation process for the two stages.

[2] ***CONFIDENTIAL***

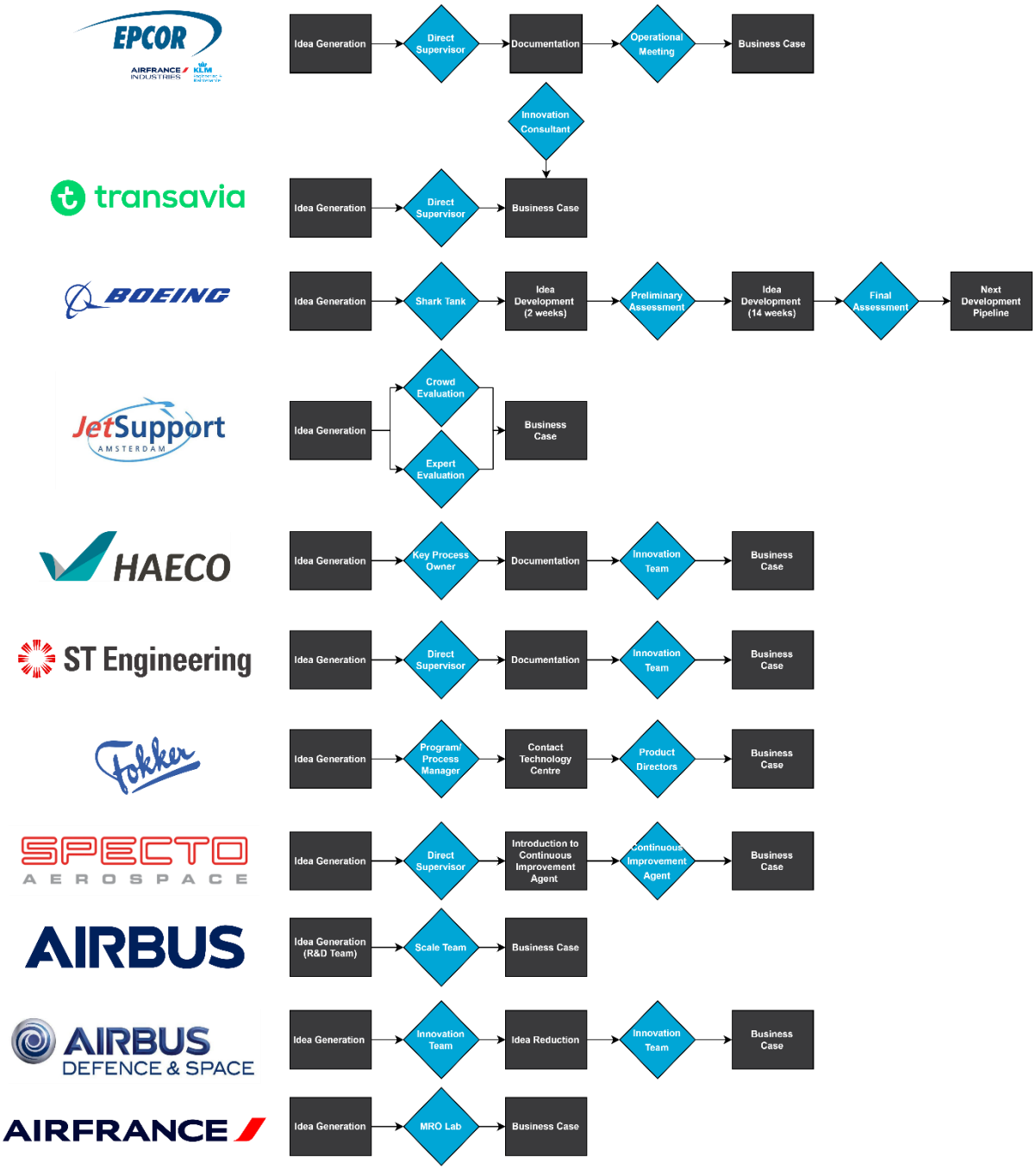


Figure 13: Idea Evaluation Process of MROs

Although each organisation has established a different idea evaluation process, many similarities can be found when critically examining Figure 13. Before comparing the twelve different processes and organisations, each process will be shortly described below. The blue hyperlink (name of the organisation) can be selected for more information.

Epcor has established a two-step evaluation process. The direct supervisor assesses the feasibility of this idea to determine whether it is worth pursuing based on his/her experience. If yes, the idea is added to the planner and assessed for a second time throughout the operational meeting (including all supervisors and the operational manager).

Transavia also utilises a two-step evaluation as the direct supervisor performs the first assessment, followed by the second assessment of the innovation consultant. The innovation consultant is not only assessing but also developing the idea and the business case throughout the innovation process.

Boeing Global Services has an entirely different process (R&D department). They utilise a pipeline setup, where each pipeline takes three months to surpass. At the beginning of the research pipeline, a first evaluation is performed to determine which ideas are entering the pipeline. Subsequently, after two of the 12 weeks, a preliminary assessment is performed to ensure that apparent failures are killed before devoting 12 weeks. At the end of the pipeline, the final assessment is performed before the idea is moved over to the following pipeline.

JetSupport has utilised an alternative strategy. They are using crowd evaluation combined with internal expert opinions. For instance, all employees can share their thoughts and experience regarding submitted ideas, which could lead to a no-go decision based on previous pilots. Simultaneously, internal experts (affected departments) and the legal department (if applicable) are asked to assess the idea critically.

HAECO ITM exploits a two-step evaluation for idea evaluation. The critical process owner makes the first assessment as he/she is close to the operation and can define and prioritise the idea. Subsequently, the innovation team developed an evaluation matrix for the second evaluation to prioritise and objectively weigh the ideas.

ST Engineering communicates ideas on the shop floor through supervisors, who already make a first assessment of the ideas. Afterwards, the innovation team mainly focuses on the idea's technical feasibility and value during the second evaluation. This also means they use a two-step evaluation process.

TUI NL has no fixed process in place for evaluating ideas. The innovation process relies on the local interaction between the manager and the teams. However, the manager has the authority to make time for team members to develop the business case around a specific idea. This means he/she is responsible for assessing the idea.

Fokker uses the program/process managers to make the first assessment. The program managers are primarily focused on the complete business case (Risks and financial aspects), and the production managers are involved as the idea might impact the production process of the layout of the shop floor. After the idea is further developed within the technology centre, the product directors perform the second evaluation.

Specto has created a basic two-step outline for the idea evaluation process. However, they also mention that there is no strict order in the process, meaning ideas can slightly deviate from the process structure. As a first assessment, the direct supervisor assesses the idea based on his gut feeling and experience. The Continuous Improvement Agent team performs the second assessment.

Airbus Scale Airbus Scale utilises a single evaluation moment. This means that the R&D team has already assessed the feasibility of ideas and other factors before entering the incubation and acceleration phase. One can mention that they are focussing on the market value of ideas. Therefore, the team of Airbus Scale is assessing the business model instead of the technology itself.

Airbus NL performs a two-step evaluation process, although the same team performs the evaluation. Firstly, the innovation team uses a voting system to reduce the number of ideas. Afterwards, they create multiple iterations of the business model canvas to discover and assess the most critical factors of the ideas.

Air France Industries does not have a fixed evaluation process in place. The evaluation process is yet to be designed as they redefine the innovation ecosystem after the covid crisis. However, innovative ideas should fit within their defined roadmap, containing more prominent themes (For instance, augmented reality). Therefore, one can mention that they are utilising a one-step evaluation process where the innovation team decides to pursue innovation.

Considering the organisation's various idea evaluation processes, considerable differences and similarities can be observed.

Firstly, Epcor, Haeco ITM, ST Engineering, Fokker, Specto, and Airbus NL utilise a two-step evaluation process. This stage-gate approach roughly follows the same structure for all organisations. When an idea is generated in operation, the direct supervisor, key process owner, or program manager performs the first evaluation of the idea. Although organisations use various names, the common denominator would be that the first assessor is part of the operation

and understands problems and needs from an operational perspective. Subsequently, the second assessment is usually performed by a separate innovation team. However, it could also be an operational meeting/product directors meeting. Across all the organisations, this second assessment aims to determine whether the idea will be further developed into a business case and whether significant resources will be invested to achieve this. Although this process might seem fixed, most organisations have highlighted the process's flexibility. For instance, as is mentioned by Specto, "There is no strict order in the whole process".

Secondly, Transavia utilises a slightly different approach as they introduced the innovation consultant role. However, the process is essentially similar to the stand two-step evaluation. The innovation consultant performs the second evaluation, possesses an assessment role and helps develop the business case.

Thirdly, Boeing Global Services uses an entirely different idea evaluation process. They have developed a "pipeline setup" used for idea development. They have established three assessment points (1) before-, (2) two weeks after entering-, and (3) at the end of the pipeline. As mentioned during the interview, "The daily operation is research and development", meaning they are not in a similar environment to the MROs. Especially since ideas are developed in pipelines of four months and require multiple pipelines before entering service, this structure would be complex for MRO organisations.

Next, JetSupport exploits two evaluation moments to determine whether an idea is worth pursuing. On the one hand, every employee within the organisation can react to proposed ideas using external expertise. On the other hand, the innovation team ensures that associated employees with relevant experience are also assing the idea. Interaction with the employees across various departments could also highlight historic trials/experiences of other departments, which is a benefit of this structure. However, one can mention that the intensive labour process of finding appropriate experts and managing the complete innovation process is suitable for smaller organisations (<100 FTE) but becomes problematic for larger organisations.

Lastly, Airbus Scale and Air France industries incorporate a single evaluation moment. Airbus Scale is organised differently from a typical MRO. They are responsible for the incubation process and the associated business model; they only accept the idea that has already surpassed the research process. Throughout this process, the technical feasibility and regulatory fit are assessed. Therefore, the idea evaluation process is divided between different departments, which might make this process not suitable for a typical MRO organisation. AFI is currently

redesigning their innovation ecosystem. The idea evaluation is performed ad hoc and requires some standardisation soon. Therefore, they assess ideas following their roadmap to ensure that ideas can fit within one of the general themes, such as carbon reduction and augmented reality.

3.2.2. THE IDEA EVALUATION CRITERIA

Twelve organisations were asked to name evaluation criteria for their idea evaluation process. Before mentioning the criteria, it is essential to note that each interviewed organisation takes a different approach to evaluating ideas. Whilst some organisations have fixed evaluation matrixes; others use the interpretation and assessment of experienced employees. It is crucial to note that when an organisation does not explicitly mention criteria, it does not necessarily mean that this criterion is not evaluated. It could also be informally evaluated through the employees' experience. All the mentioned requirements can be found in Table 8.

Table 8: Idea Evaluation Criteria MROs

Organisation	Evaluation Criteria
Epcor	Feasibility (Technical), "Worth pursuing" (Operational), Financial measure
Transavia	*No predetermined requirements*
Boeing Global Services	Value proposition, Go-to-market Strategy, Technical feasibility, ROI, Potential competitors, Strategic alignment, Competitive advantage, Definition of the idea vision, and Customer need.
JetSupport	(Technical) Feasibility, Usability, Regulatory, and Financial measure
HAECO ITM	Total costs, ROI, Synergy of idea with other business units (Strategic Fit), timeline, complexity.
ST Engineering	Technical Feasibility, The value of the idea (value proposition), Usability, Acceptance of the workforce, Logistics, and Training
TUI NL	Technical Feasibility
Fokker	Technology Readiness Level and Financial measure
Specto	Idea History, Idea Relevance
Airbus Scale	Idea Maturity, Strategic Fit, Customer Fit, Linkages with R&T/R&T priorities, Capacity to Finance, Uniqueness of the proposal, and TRL level
Airbus NL	Passion, Growth Potential, Available Funding, Fit with organisational capabilities, Must-haves, Horizon Levels
Air France Industries	ROI, Operational Feasibility, and time to implement

Throughout the exploratory interviews, it became evident that the various organisations have contrasting ways of utilising the evaluation criteria, impacting how well the criteria are defined. For instance, HAECO ITM has developed a matrix to weigh and prioritise ideas, whilst TUI Fly NL has no specific matrix nor many predefined requirements to evaluate innovative ideas.

The following table will compare the criteria mentioned by the twelve organisations with the generic literature requirements. In the literature review, only criteria mentioned at least twice were considered. In Table 9, at least one of the interviewees mentioned the additional requirements described. The complete table can be found in Appendix III: Criteria Definitions.

Table 9: Additional MRO Requirement (Compared to the Literature)

Criteria	Organisation
Go-to-market Strategy	Boeing Global Services
Competitive Advantage	Boeing Global Services
Customer Need	Boeing Global Services, Airbus Scale
Usability	JetSupport, ST Engineering
Definition of the idea's vision	Boeing Global Services
Value Proposition	Boeing Global Services, ST Engineering
Product Complexity	Haeco ITM
Product History	Specto
Operational Feasibility	Epcor, Specto
Financial Feasibility	Epcor, JetSupport, Fokker, Airbus Scale, Airbus NL
Acceptance of the workforce	ST Engineering, Airbus NL

Therefore, the abovementioned criteria are also relevant when designing an idea evaluation framework for MRO organisations. The total number of criteria that will be considered is 28, consisting of literature (17) and expert interviews (11).

4. IDEA EVALUATION FRAMEWORK

The framework aims to empower MRO organisations to design their idea evaluation process based on their specific needs. Although the process will vary due to organisational characteristics, this framework aims to be the foundation for this organisational-specific process. Hence, the following sub-question is addressed within this section:

SQ3: What is the ideal framework for idea evaluation, adapted for the aviation MRO?

The origin of this framework lies in the combination of the literature, section (2), and the industry-specific interviews, Section (3). The framework focuses on the preliminary assessment before ideas are turned into a business case (Figure 14). It serves as a first filter to quickly assess and select potential promising ideas for the organisation.

Figure 14: Framework Sub-process

Throughout this phase, survey research is applied to determine which of the 28 criteria are relevant for the MRO industry. Due to the geographical diversity of aviation organisations, an electronic questionnaire is utilised for this research (Sekaran & Bougie, 2016).

Expert Selection

The evaluation framework is designed explicitly for the MRO; thus, three experts per MRO category were selected. Additionally, as the criteria are compared and weighted, an evenly distributed sub-group is required to ensure equal distribution. The expert selection process and additional information regarding the respondents can be found in Appendix IV: Expert Survey.

Survey Design and Analyses

The Delft University of Technology has assessed multiple survey tools on privacy and security, whereas Microsoft Forms received positive advice on privacy and security (TU Delft, 2022). Therefore, this program is utilised to collect the required responses.

The survey asked MRO experts to select relevant assessment criteria applicable to the idea evaluation phase of the FEI. Additionally, a control question was included to ensure that all relevant criteria were considered within the survey. The control question was: *Does the previous section include all relevant criteria? Or do you feel a criterion is missing? If so, please name them here*. Finally, to collect insight regarding the importance of one criterion over another, the last question asked the respondents to prioritise the top five criteria, starting with the most important one. The complete survey can be found in Appendix IV: Expert Survey.

Once at least two experts select a criterion, it is added to the "to be considered" criteria list. The most important criteria are integrated into the first evaluation moment, called the initial screen. The expert survey should determine which criteria are relevant to integrate into the initial screen and preliminary evaluation. Once the data is reduced, it is presented in the subsequent section. Afterwards, concluding remarks can be made based on the expert survey results.

The remainder of this section includes the framework design, section (**4.1**), an explanation of the framework steps, section (**4.2**), and the framework discussion (**4.3**)

4.1. FRAMEWORK DESIGN

Based on the literature review, the idea evaluation process should consist of a multi-stage selection process because the uncertainty reduces over time, and more information becomes available throughout the process (Rochford, 1991). The three models described in the literature incorporate various elements that could be utilised within the framework. For instance, the stage gate model includes technical- and market research before the second assessment (Cooper, 1988). Moreover, the New Concept Development model explicitly mentions prioritising ideas after evaluation (Koen et al., 2002). Lastly, Integrative Front-end Process Model provides the ability for organisations to focus on a market or technological opportunity explicitly (Sandmeier et al., 2004). The exploratory interview with twelve aviation organisations revealed that half of the organisations utilise a stage gate approach. However, the stages and sequence are not permanently fixed. Other forms, such as the pipeline setup (Boeing Global Services) and the single evaluation (Airbus Scale), are not suitable for this framework, as these models can be traced back to organisational characteristics that do not apply to the MRO organisations.
Thus, this research suggests a two-step idea evaluation process based on the stage gate model, including the prioritisation integrated into the second evaluation. Additionally, the market or technological opportunity should be added to the model as an option for organisations. A visual representation is provided in Figure 15: Idea Evaluation Framework.

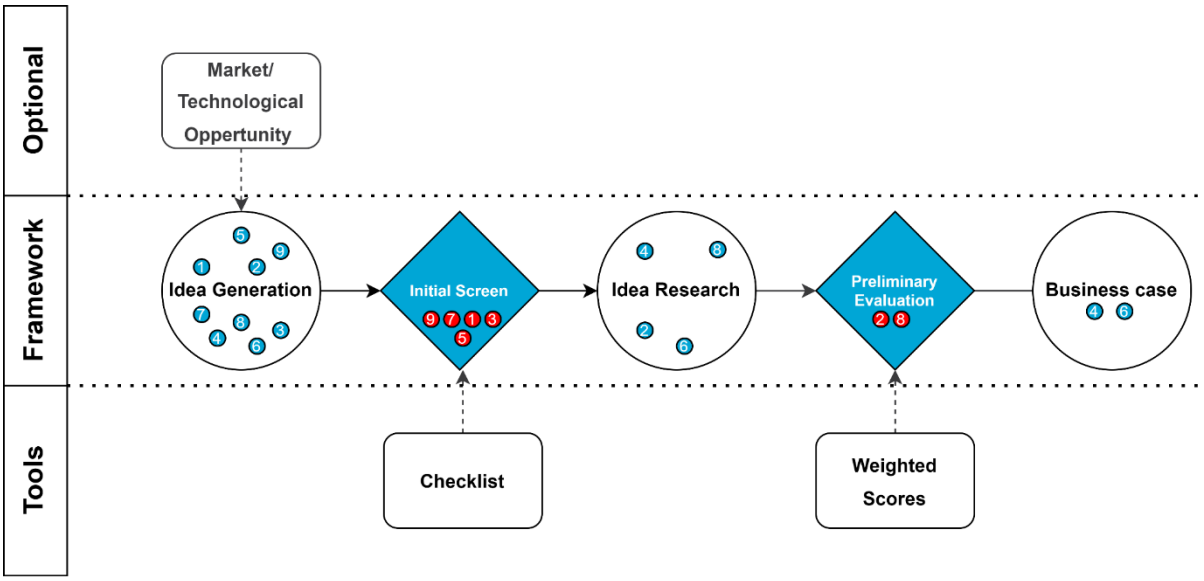


Figure 15: Idea Evaluation Framework

4.2. FRAMEWORK STEPS

This section describes the different steps within the idea evaluation framework (Figure 15). The main steps of the framework are Idea Generation (**4.2.1**), Initial Screen (**4.2.2**), Market/Technical Research (**4.2.3**), and Preliminary evaluation (**4.2.4**). The four main steps of the framework are elaborated below.

4.2.1. IDEA GENERATION

Although the idea generation phase is out of the scope of this framework, it is essential to coordinate idea generation and idea evaluation. For instance, as mentioned by Boeing Global Services, they utilise a one-pager format for the idea documentation throughout the process. Additionally, Jet Support has already incorporated questions such as (1) what are three potential solutions, (2) What part of the organisation is affected by the problem/idea, (3) who is the problem owner, and (4) what will be the result of the idea (Reduce costs, prevent incidents). These questions could allow organisations to prepare ideas for the evaluation moments. Therefore, the key objective of this phase, within the boundaries of the framework, is to design and create a presentable format for idea documentation and communication. This ensures the ideas are presented in a format that allows for assessing ideas.

4.2.2. INITIAL SCREEN

The initial screen is the first filter for the generated ideas. This phase aims to evaluate and assess ideas to kill prominent misfit projects. Due to the high levels of certainty, this assessment only allows the organisation to assess ideas abstractly. Therefore, a checklist is selected as the

appropriate method for accommodating this first evaluation. The checklist should establish the foundation for the idea evaluation process and typically includes open-ended questions for idea evaluation.

A survey containing twelve MRO experts revealed which criteria were deemed relevant within the MRO boundaries. This survey revealed that five criteria are mentioned as the most important to evaluate throughout the idea evaluation process, based upon the average of each MRO expert, as can be found in Appendix IV: Expert Survey. (1) Strategic fit is mentioned as the most crucial criteria to evaluate, followed by (2) Customer Need, (3) Value Proposition, (4) Return on Investment, and (5) Acceptance of the workforce.

Therefore, the key objective of this phase is to consider the following criteria as a starting point for designing the checklist to aid the first evaluation phase. This ensures that organisations have considered various criteria before designing the evaluation checklist and that evaluators have a standardised checklist to evaluate ideas.

4.2.3. IDEA RESEARCH

Preliminary idea research should be performed throughout this phase to collect sufficient information to complete the preliminary evaluation. Hence, the seven evaluation criteria categories presented in the framework should be incorporated in this phase. There are time and budget constraints, but this should not incorporate a comprehensive market or technical analysis; however, it should briefly touch upon each category. For example, an approach would be a very small pilot to evaluate the technical feasibility or perform a stakeholder analysis to assess the acceptance of the workforce.

4.2.4. PRELIMINARY EVALUATION

The second evaluation proposed by the framework should be designed to incorporate more detailed criteria than the initial screen. Therefore, the framework proposes a weighted score matrix to evaluate and prioritise ideas. The advantage of utilising this methodology is that each idea received a specific score, allowing for comparing ideas. Next, a survey containing twelve MRO experts was conducted to reveal which criteria were deemed relevant to evaluate within the MRO context. The criteria essential to evaluate throughout the preliminary evaluation are presented in Table 10 and Appendix IV: Expert Survey.

This framework incorporates criteria mentioned by more than half of the experts, resulting in a 50%> score. The percentage in Table 10 is based on the amount of 12 experts who mention this criterion deemed relevant to evaluate. For instance, when all 12 experts mention criterion X as

essential, it receives a score of 100%. Fifteen criteria are deemed relevant as the foundation for the idea evaluation process.

Table 10: Preliminary Evaluation Criteria

Category	Keyword	Percentage of total experts
Market	Customer Satisfaction	75,00%
	Competitive Advantage	66,67%
	Customer Need	66,67%
Product/ Process	Strategic Fit	75,00%
	Usability	75,00%
	Value Proposition	83,33%
Feasibility	Technical Feasibility	91,67%
	Legal Feasibility	66,67%
	Operational Feasibility	100,00%
	Financial Feasibility	66,67%
Compatibility	Synergy	58,33%
Time	Time to market	58,33%
Financial	Return on Investment	58,33%
Other	Acceptance of the workforce	91,67%

4.3. FRAMEWORK DISCUSSION

This section aimed to reveal the idea evaluation framework tailored explicitly toward the aviation MRO industry. The literature and the exploratory interviews proposed a multi-step evaluation process based on the stage-gate model. This process incorporates two evaluation moments called the initial screen and preliminary evaluation. Firstly, the initial screen proposes to design a checklist with five criteria (Strategic fit, Customer Need, Value Proposition, Return on Investment, and Acceptance of the workforce) to filter out obvious misfits. Secondly, the preliminary evaluation advises an evaluation matrix to evaluate and prioritise ideas. Hence, fourteen criteria were deemed relevant to incorporate in the second evaluation moment (Customer Satisfaction, Competitive Advantage, Customer Need, Strategic Fit, Usability, Value Proposition, Technical Feasibility, Legal Feasibility, Operational Feasibility, Financial Feasibility, Synergy, Time to market, Return on Investment, Acceptance of the workforce).

The findings of this section are mostly in line with existing research. The literature review and exploratory interviews exposed the need for evaluation criteria to manage the idea evaluation process as part of the FEI. This is in line with the findings of Chanaron et al. (2011). Additionally, the expert interviews expressed the urge for a structured innovation process, endorsed in the literature by Kock et al. (2016). The intense focus on the customer's perspective within this framework (e.g., customer needs and acceptance of the workforce as the internal customer) is aligned with the findings of Cui & Wang (2017). They stipulate the importance of integrating customers into the new product development process.

Nevertheless, one can mention that the MRO expert interviews significantly impacted the idea evaluation criteria as from the fifteen criteria, six are (Customer Need, Usability, Value Proposition, Operational Feasibility, Financial feasibility, and Acceptance of the workforce) originated from the interviews. They were not discovered throughout the literature review.

When considering the five requirements from the initial screen, historical research revealed the urge to evaluate Strategic Fit, Market Potential, and (Preliminary) Feasibility. This is relatively similar to the five evaluation criteria presented in the framework. However, the market potential is not incorporated into the framework. A possible explanation might be that MRO organisations focus on pursuing internal innovation instead of developing ideas for their market potential. Throughout the exploratory interviews, nearly all MRO organisations aim for organisational improvement instead of actively selling innovations. For instance, the vision of Epcor revealed that they are aiming to "Being the best MRO Shop", indirectly revealing they are targeting continuous internal improvements.

Lastly, the relative unique characteristics of the aviation industry are also impacting the idea evaluation framework. The unprecedented safety regulations and operational environment create a challenging climate for innovation. As mentioned by Jet Support, roughly 25% of all generated ideas are not pursued or require adjustments to be within the regulatory requirements. Therefore, impacting both the process and evaluation criteria of the innovation process. Another example is HEACO ITM, where the team manager should assess whether regulations can hamper the innovative idea. As mentioned above, legal feasibility is a separate element in the idea evaluation framework. Regarding the operational environment, this primarily impacts the innovative throughput of the idea evaluation process; however, there is no direct relationship with the evaluation criteria or process observed in the exploratory interviews.

5. CASE STUDY: KLM E&M

This case study aims to assess whether the newly proposed ideal framework can be applied within the context of the aviation MRO sector. Additionally, the case study examines how the organisational context impacts the proposed framework. Although the idea evaluation framework provides the foundation for the idea evaluation process, this section designs the complete process, allowing this research to gain valuable insights to enhance the proposed framework. Therefore, the following sub-question is addressed in this section:

SQ4: How can the ideal framework be applied within the aviation MRO?

This instrumental case study incorporates data based on multiple sources of evidence. A combination of desk research and interviews was used to locate and collect the required information for this case study. Firstly, formalised processes, procedures, and relevant documentation described in the database of KLM E&M were studied to collect information. Secondly, unstructured interviews were used to explore the phenomenon of idea evaluation within KLM E&M and confirm additional relevant information that could not be collected with the help of desk research. Finally, multiple expert panels were organised to review the proposed framework with the assistance of innovation experts within KLM E&M (as part of "focus group research"). A focus group is "a data collection technique that gathers data through group interaction regarding a pre-selected topic" (Chionce & van der Veen, 2001). This focus group aims to establish an idea evaluation process based on the designed framework.

The interviewees of the unstructured interviews were selected based on their current role within the idea evaluation process. The Innovation Project & Process Manager is currently responsible for evaluating ideas and developing business cases. Therefore, this person is deemed relevant for the interviews to determine the current situation at KLM E&M. Additionally, the second interview was performed with a Continuous Improvement Lead, as this person is a member of the innovation council, where ideas are currently shared. Hence, this person can elaborate on the current idea generation and evaluation process. The various expert groups incorporated a mixture of members of the improvement team. More details are provided per expert in Appendix V: Case Study Interviews.

The remainder of this section presents background information in section (**5.1**), followed by the description of the current process in section (**5.2**). Subsequently, an enhanced idea evaluation process is designed in section (**5.3**) and compared with the framework in section (**5.4**).

5.1. BACKGROUND

KLM has acknowledged that they want to *Pioneer Sustainable Aviation*, aiming to increase the sustainability of its organisation and the entire aviation industry (Air France KLM Group, 2022). Likewise, KLM introduced the target of *zero emissions from ground operations by 2030*, which they are already pursuing by the electrification of ground equipment and the placement of solar panels on the roof of the hangers. (Hve, 2020; KLM Royal Dutch Airlines, 2020).

In order to pursue the target for ground operations, KLM E&M has introduced a new movement called "*Bold Moves*", where they are working on seven projects, each aiming to contribute to the sustainability targets of KLM. One of the projects is "*close our energy loop*", explicitly aiming to create an ecosystem, including a knowledge centre, to start re-using energy produced during the MRO operation. When promising ideas regarding sustainability are generated and brought to the attention of the knowledge centre, it is essential to establish a process that allows KLM to assess the potential and feasibility of the idea before it is developed into a concept. Hence, the framework designed throughout this research can be used to establish a process for KLM E&M to evaluate sustainable ideas.

5.2. CURRENT PROCESS

Afore the framework can be applied and the associated process can be designed, it is essential to understand the core problem. Therefore, two KLM E&M employees were interviewed to understand the current process and identify the pain points. The interviews can be found in Appendix V: Case Study Interviews.

As of today, the Covid-19 crisis disrupted the KLM E&M innovation ecosystem. For instance, two of the three innovative units are stopped or restructured, and the third one is significantly reduced in size. The current idea evaluation process depends on the network and connections of the innovation manager and continuous improvement leads. In current circumstances, the amount of ideas allows for the ad hoc process; However, the increasing number of ideas expands the need for a structured process. Additionally, as mentioned by a CIL, the current process lacks transparency for the work floor. It creates uncertainty on whether ideas are pursued or not and the reasoning behind this decision. Thus both interviewees confirm the need for an idea evaluation process to guide the assessors and the work floor and provide a transparent process for the whole organisation.

5.3. PROPOSED IDEA EVALUATION PROCESS

This section aims to apply the proposed idea evaluation framework within the organisational boundaries of KLM E&M. The framework serves as the foundation for the process designed within this section. Essential to note is that this process will be specifically geared towards evaluating sustainable ideas. The designed idea evaluation process can be found in Figure 16.

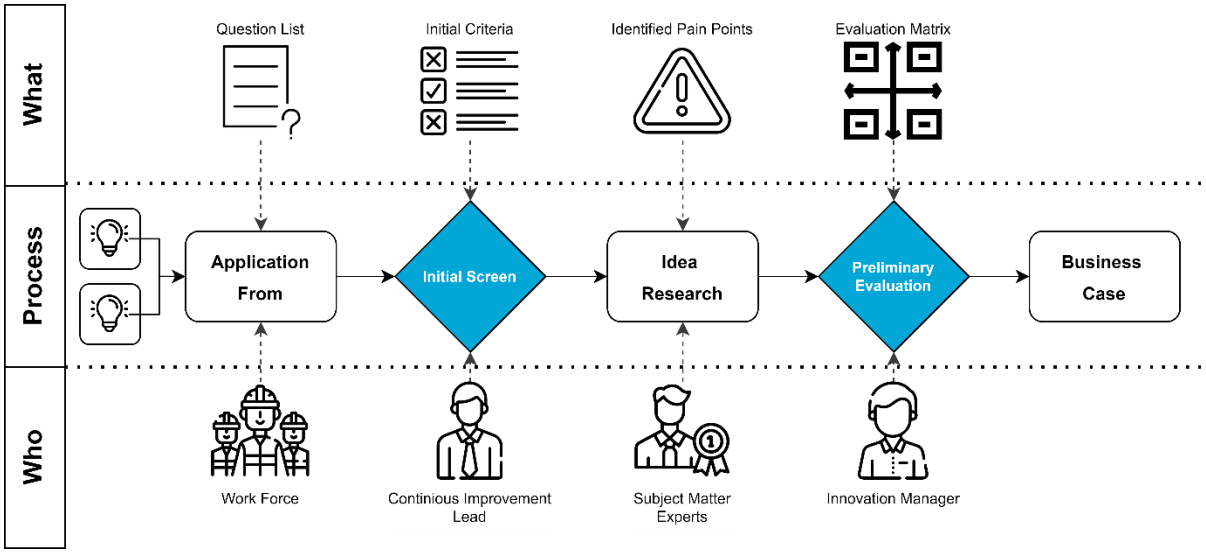


Figure 16: KLM E&M Proposed Idea Evaluation Process

Although the idea generation phase is out of the scope of the framework, it is vital to establish the foundation for the application form, as this provides the basis for the initial screen. Therefore, the expert panel proposed a question list as a starting point (Appendix: Expert group 3: Process Review). Although the workforce needs to fill in the application form, Continuous Improvement Leads (CIL) can assist them in answering the questions.

Initial screen

Subsequently, the CIL performs the initial evaluation, as they are the connection between the workforce and the innovation team. According to the Innovation Project & Process Manager and CIL, Table 11 presents the criteria deemed relevant to assess throughout the initial screen. Additional information regarding the inclusion or exclusion of criteria can be found in Appendix Expert group 1: Initial Screen. During the first evaluation moment, the CIL identifies the most significant pain points and uncertainties to determine which subject matter experts (SMEs) are relevant to contact. This allows for the collection of information to aid the preliminary evaluation. For instance, When evaluating an idea related to Augmented Reality, other related project experts could be consulted to assess the feasibility of the idea based on their experience.

Table 11: Initial Screen Criteria KLM E&M

Criteria	Expert Motivation
Value Proposition	The value proposition should include information on how the problem is going to be addressed by the idea. By designing the various categories (reduce costs or prevent accidents), one could prevent the employees on the shop floor from focussing on all aspects, even though they might be irrelevant at this stage.
Acceptance of the Workforce	For all ideas, it is essential to test the willingness and acceptance of the workforce to work with the new idea. Is there an actual broader need apart from the initiator of the idea? How is the impacted workforce responding?
Customer Need	We often think that one needs an innovation; however, it frequently turns out to be a wrong assumption. Therefore, we need to assess if we are pursuing ideas because of an actual need and not because we think it is necessary.
Time to Implementation	Based on experience, it can also happen that the customer needs change over time, especially when the implementation has a significant duration. Therefore, assessing the idea's duration could also be relevant.
Newness of the Innovation	When an idea is classified as "radical", and very out of the scope of the day-to-day operation, there needs to be a different way of assessing those ideas. The duration is usually very long, incorporating high financial costs; however, it is also an opportunity you do not want to miss an organisation.

Preliminary Evaluation

The second evaluation incorporates a matrix to evaluate and prioritise generated ideas. As this process is tailored towards sustainability, an impact-effort matrix is designed to score the ideas against sustainable targets. The matrix is designed using an expert group, including six members (Blackbelts, Continuous Improvement Lead, and Innovation Manager). The Appendix (Expert group 2: Preliminary Evaluation) describes the expert panel.

This expert group aimed to complete the following aspects to determine the effort score of an initiative: (1) Determine which criteria are relevant to evaluate, (2) determine the weight of each relevant criterion, and (3) determine the scale of the criteria to determine the overall score.

Firstly, the 1-2-4-All methodology focused on individual and collective intelligence (Klaxoon, 2022). This method includes multiple rounds to determine the relevant idea evaluation criteria. The methodology is adjusted (the round incorporating four is removed) as only six attendees were present in the meeting. This resulted in five criteria deemed relevant: organisational change, feasibility, required capacity, required investment, and project duration. Throughout the expert panel, the effort criteria defined during the expert panel were compared against the predefined framework criteria for the preliminary evaluation. This resulted in some changes, such as adjusting technical feasibility towards feasibility to incorporate aspects such as safety, security, and regulations.

Secondly, after the criteria were determined, a weight had to be assigned to decide the relevance of each criterion. During the expert panel, the following scores were assigned per criteria (Figure 17) based on the experts' votes. Each expert could devote a total of 100 points.

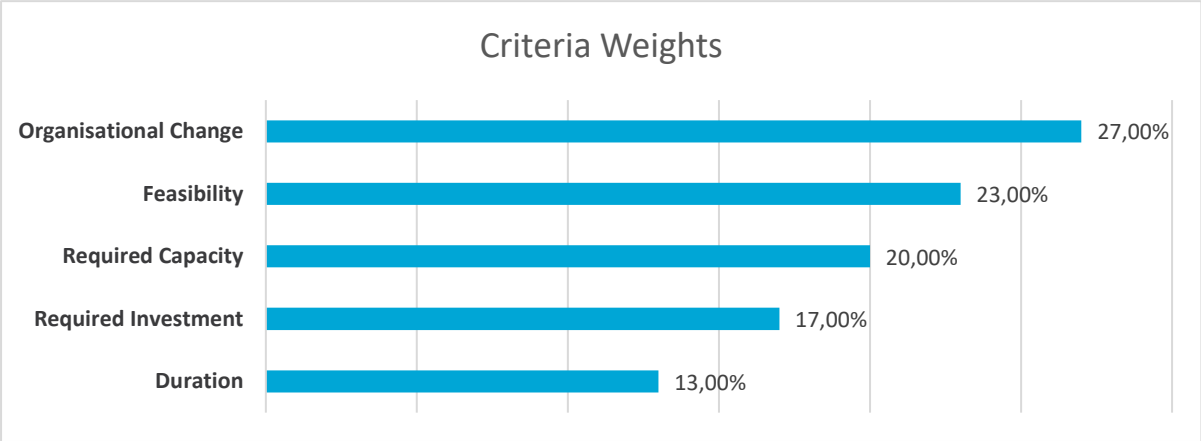


Figure 17: Criteria Weights

Thirdly, scoring scales were designed to enhance objective evaluation as the effort criteria were designed with a relative weight throughout the expert panel. The following criteria were deemed relevant when evaluating sustainable projects within KLM E&M, as seen in Table 12.

Table 12: Effort Criteria

Effort Criteria		Score				
Category	Explanation	1	2	3	4	5
Organisational Change	The amount of expected resistance within the organisation is determined by the combination of the (1) Size of the impacted group and (2) The amount of resistance expected per inidvidual (top-down or botom-up).	Nil	Slight	Average	Large	Major
Feasibility	The state or degree of being easily or conveniently done. Relevent aspects include: Technical, Safety, Security, IT, Management support, operational and Regulations.	Very high	High	Average	Low	Very Low
Required Capacity	The amount of manhours that are required to implement the project.	<40	40-500	500-1.500	1.500-5.000	5.000>
Required Investment	The amount of financial investment that is required to implement the project	<15.000	15.000 - 500.000	500.000 - 5mln	5 mln - 25 mln	>25 mln
Project Duration	The amount of time it takes to implement the project	< 1 month	1 month - 3 months	3 months - 6 months	6 months- 1,5 year	>1,5 year

An idea's impact is measured against KLM's sustainable targets, which are related to the Sustainable development goals (SDGs) but are defined based on the needs of KLM. The targets deemed relevant for this framework are Clean Energy (SDG 7), Working Conditions (SDG 8), Innovations (SDG 9), Responsible Consumption (SDG 12), and Climate Action (SDG 13). The impact criteria are visualised in Table 13.

Table 13: Impact Criteria

Impact Criteria		Score				
Category	Explanation	1	2	3	4	5
Energy	The reduction of electricity/water and the production of "clean" energy	Minimal Impact	Slight Impact	Significant Impact	Large Impact	Major Impact
Working Conditions	The working conditions, such as ergonomics, wage, safety, health, facilities, and absenteeism.	Minimal Impact	Slight Impact	Significant Impact	Large Impact	Major Impact
Innovation	Improving and investing in the infrastructure, processes, and equipment to ensure continency of the organisation	Minimal Impact	Slight Impact	Significant Impact	Large Impact	Major Impact
Responsible Consumption	50% waste reduction of non-hazardous waste using 9R framework OR Hazardous: harmful to the environment	Minimal Impact	Slight Impact	Significant Impact	Large Impact	Major Impact
Climate Action	CO2 reduction or recuperation of kerosine, fuel, and/or gas	Minimal impact	Slight Impact	Significant Impact	Large Impact	Major Impact

Idea evaluation process

At this stage, both the impact and effort criteria are defined above, meaning that ideas could be evaluated and plotted within the matrix. Therefore a scoring table is utilised to evaluate the different initiatives, as is shown in Table 14.

Table 14: Idea Evaluation Scoring Sheet

	EFFORT						IMPACT
Projects	Organisational Change	Feasibility	Required Capacity	Required Investment	Project Duration	Effort Score	Impact Score
	0,28	0,23	0,2	0,17	0,13		
Vendor Arrangements	4	4	4	2	5	3,8	4
Employee Awareness	3	2	2	1	4	2,4	4
Stop Single Use Cups	3	1	2	1	2	1,9	2
Update SAP System	1	3	3	1	3	2,1	3

The values included in the figure above are based on current and ongoing ideas within KLM E&M. Hence, the scores are for illustrative purposes and are not analysed by experts. The preliminary reasoning behind the scores can be found in Appendix VI: Evaluated Ideas. A visual representation of the matrix is presented in Figure 18.

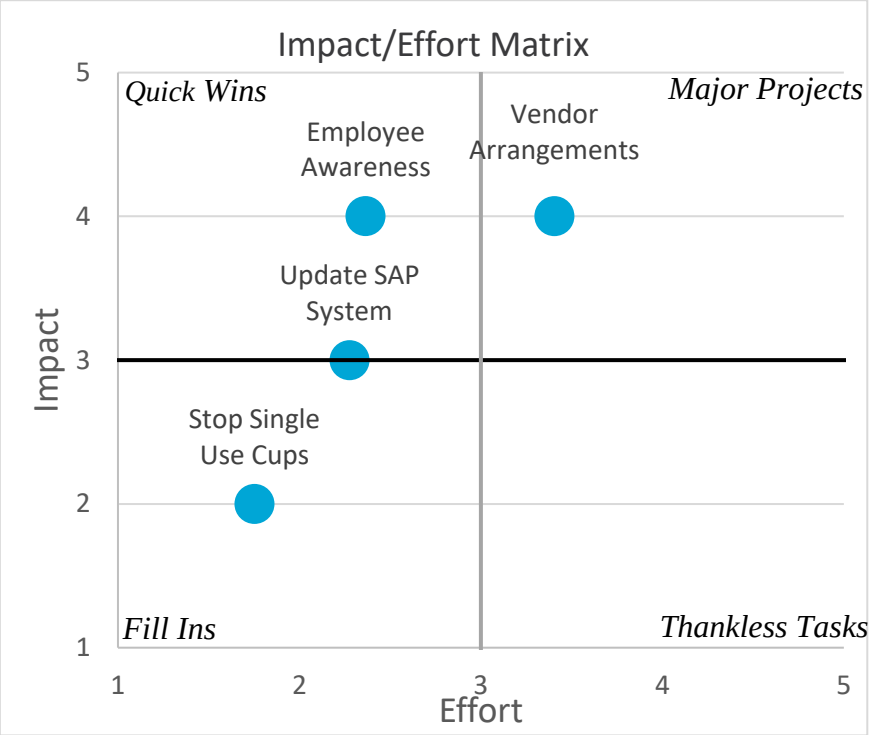


Figure 18: Impact/Effort Matrix

The advantage of utilising an effort-impact matrix is that it allows evaluators to create a structured overview of the relevant projects. This allows the organisation to optimally manage its time as high-effort ideas can be performed simultaneously with low-effort ideas when allowed by the organisation's capacity. The matrix is divided into four quadrants, each indicating a specific classification (MindTools, 2022).

Quick Wins - (High Impact, Low Effort) are attractive to an organisation as they achieve high impact while using low effort. These projects are usually top priorities and are the main focus.

Major Projects - (High Impact, High Effort) contribute significantly to the designated target. However, they are also time-consuming and often relative complex to perform.

Fill Ins (Low Impact, Low Effort) have a low priority but are often mentioned as just-do-its when spare time exists. These projects are dropped out when more impactful projects arise.

Thankless Tasks (Low Impact, High Effort) are often avoided by an organisation as they heavily consume resources and generate an insignificant impact on the desired target.

5.4. CASE STUDY DISCUSSION

The case study aimed to assess whether the newly proposed ideal framework could be applied within the context of the aviation MRO sector and how this context impacted the framework.

Answering the first aspect, based on the findings of this case study, one can mention that the proposed framework can serve as the foundation for the idea evaluation process. The process of the idea evaluation remained the same and could be integrated within the organisational context of KLM E&M. Subsequently, nil criteria were deemed missing when implementing the framework. However, the results do not shed light on other MRO organisations as this section incorporated a single case study.

Answering the second aspect, the organisational context significantly impacts the proposed idea evaluation framework. In particular, the transfer from a framework to an organisational process. As mentioned above, KLM E&M focuses on sustainability, resulting in an alternative prioritisation of the evaluation criteria compared to the proposed framework.

Next, the organisation's size also impacted the process criteria, such as strategic fit, as mentioned by the CIL: "The strategic fit could be relevant for small to medium enterprises, where the direction and strategic objective are more evident to the workforce. However, it is tricky to assess within the initial screen at KLM E&M due to the size of the organisation".

The practical contribution of the idea evaluation lies in establishing a uniform and clearly-structured idea evaluation process within KLM E&M. Both the innovation manager and continuous improvement leads stipulate that the current process requires a more structured process with the increasing amount of ideas, as today's decisions are made ad hoc and based on the network of the evaluators. Additionally, the current process lacks transparency to understand why specific ideas are (or are not) going to be pursued after they are submitted.

These desires are enhanced by implementing the idea evaluation, which created a structured four-step approach incorporating subject matter experts and two evaluation moments with predetermined criteria. Firstly, from the workforce perspective, the predetermined steps and criteria present a transparent process for the workforce, resulting in an enhanced understanding of how ideas are evaluated during the two evaluation moments and which criteria are relevant to consider before submitting the idea. Secondly, from an organisational perspective, the desire for a structured process to handle the increasing number of ideas is also augmented by the idea evaluation framework. Introducing more structure into the evaluation process supports idea

evaluators throughout the process. For instance, relevant subject matter experts are documented and stored within the idea evaluation process, which makes it easy for evaluators to find the appropriate employees or detect a “knowledge gap” when there is no expert on a specific topic. In the previous process, this was not documented, and evaluators individually searched for the appropriate employees and information. Therefore, the framework eventually enhances the innovation speed as the evaluators are aware of (1) how to evaluate innovative ideas, (2) where the relevant expertise is located, and (3) which steps to follow to complete the evaluation process.

From today onwards, KLM E&M can utilise this framework to pursue its ambition to *Pioneer Sustainable Aviation*. They aim to design a knowledge centre, incorporating internal and external expertise, starting with the theme of re-using residual heat and energy from the operation. The proposed framework can serve as the foundation for the knowledge centre, proposing an idea evaluation process suitable for evaluating various initiatives aiming to re-use residual heat, which can potentially be expanded to various sustainable initiatives. The following steps for KLM should be to perform a proof of concept to validate the practicability and robustness of the process. Additionally, the backlog, incorporating (1) subject matter experts, (2) idea documentation, and (3) online evaluation forms, should be designed before the process can be implemented within KLM E&M.

6. RESEARCH DISCUSSION

Due to the fierce climate regulations, Maintenance Repair and Overhaul (MRO) organisations could benefit from an overarching framework to better understand the front-end of innovation (FEI) (Eling & Herstatt, 2017). This research contributes to the FEI literature by examining how MRO organisations can organise their idea evaluation process. Based on generic literature and explorative interviews, an idea evaluation framework was proposed to serve as the foundation of MRO organisations. Subsequently, an instrumental case study was utilised to apply the proposed framework within the organisational context of KLM Engineering and Maintenance (E&M). The remainder of this section presents the theoretical implications in section (**6.1**), the practical implications in section (**6.2**), the research limitation in section (**6.3**), and the recommendations for future research are presented in section (**6.4**).

6.1. THEORETICAL IMPLICATIONS

This research adds to an enhanced understanding of the evaluation process within the FEI.

Firstly, this research aims to close the academic gap of formal processes' absence by combining generic literature with industry-specific insights. As Barczak et al. (2008) acknowledged, formal processes are absent for idea evaluation during the FEI, resulting in non-ideal selection and a potential loss of promising ideas. Therefore, this study contributes to the existing literature by providing means to establish an idea evaluation process by utilising the framework.

Secondly, this research extends the literature by expanding the idea evaluation framework to a new and uncultivated context (Aviation-MRO). As revealed within this research, the 12 interviewed MRO experts identified 11 evaluation criteria that were not deemed relevant by generic literature but were mentioned during the interviews. These new insights are expanding the current literature regarding the idea evaluation process within organisations.

Thirdly, this research underscores the effect of the organisational context on the idea evaluation process. As stated by Marisa Dziallas (2020), the expert views proposed in the case study of the automotive industry might not be transferable to other industries. One can mention that this research confirmed these conjectures as some of the expert evaluation criteria proposed in this research are authentic compared to the automotive industry. For instance, the MRO experts do not mention communication potential, but it is deemed one of the most critical criteria according to the experts within the automotive context. As was presented in the framework discussion, various industry-specific characteristics impacted the relevance of various evaluation criteria, resulting in an industry-specific framework.

6.2. PRACTICAL IMPLICATIONS

This research underlines practical implications useful for practitioners of the framework.

Firstly, this research emphasises the need for structure within the idea evaluation process. More than ever, the increasing pressure on the aviation industry is forcing organisations to innovate. Hence, the organisation must support the idea evaluation process to ensure the organisation can capitalise upon potential promising ideas. Hence, without organisational support, the implementation of the framework will not aid an improvement of the idea evaluation process. As is found by Kock (2016), enhancing the quality of the decision process increases innovation and organisational performance.

Secondly, introducing the evaluation criteria, combined with the supporting tools (matrix and checklist), can aid the innovation team in enhancing the innovation speed and detecting failures on time to avoid wasting resources. This can be achieved by introducing a uniform assessment methodology to ensure all ideas are evaluated and prioritised according to common standards. This also allows for a transparent innovation process, deemed essential in this research (Barczak et al., 2008).

Third, the proposed impact effort matrix is geared explicitly towards sustainable initiatives. Although most organisational innovations are related to sustainability, not all are directly related to the proposed categories and have sustainability as the main driver. One can mention that those cannot be evaluated with the proposed framework due to the initial focus. However, the impact and effort criteria can also be reiterated to accommodate those innovations.

6.3. RESEARCH LIMITATIONS

The results presented in this research are prone to some limitations.

First and foremost, the proposed idea evaluation process designed in the KLM case study is not directly applicable within an organisation, as the organisational context impacts the process and the criteria. Even though the generalisability of the case study results is limited, MRO organisation can utilise the idea evaluation framework as a starting point for designing a similar evaluation process as is achieved for KLM. As concluded by the case study, there is no one-size-fits-all process for evaluating ideas, and each organisation should individually determine which framework criteria are deemed relevant to the organisation.

Secondly, the semi-structured interviews and the survey incorporated a small group of experts from the MRO industry. They were carefully selected and classified based on the varying characteristics of the industry. Even though all experts were carefully selected and classified based on the varying characteristics of the industry, the size of the sample (due to time limitations) might not represent the industry at large. However, the results can serve as an introductory guide.

Thirdly, as the aviation industry and KLM E&M are mainly pursuing incremental innovations, the idea evaluation framework and process are tailored to accommodate the evaluation of incremental innovations, not incorporating radical innovations. As described in the literature review, various types of innovations require different evaluation mechanisms. Therefore, both the framework and the evaluation process (KLM E&M) require an alternative evaluation trajectory when they want to pursue radical innovation.

6.4. FUTURE RESEARCH

Firstly, future research must validate the proposed idea evaluation criteria and process within the case study. The criteria and the process must be tested in practice to determine potential growing paint and iterate on the framework and process. Although the KLM E&M innovation team designed the idea evaluation process and determined the criteria, the practicability and robustness of the process were not validated within this research.

Secondly, the proposed idea evaluation framework considered both the process and criteria but did not thoroughly analyse the role and impact of the idea evaluator on the complete process. This research can serve as a starting point (previously mentioned as a foundation) for establishing the idea evaluation process; however, other aspects, such as evaluators and management of the backlog, are not integrated into the framework or case study and therefore require additional research.

Thirdly, from a scientific perspective, additional case studies in the field of aviation-MRO need to be performed to analyse how varying case studies impact the framework. The preliminary conclusion of the “There is no one-size-fits-all” process requires additional studies to support this argument. Another advantage of multiple case studies would incorporate the ability to detect whether the framework needs to integrate additional requirements, which was not applicable in the case of KLM E&M. A subsequent step would be to examine different MRO organisations, apart from an Airline-operated multidisciplinary MRO (KLM E&M).

7. RESEARCH CONCLUSION

This research aimed to reveal how the aviation-Maintenance Repair and Overhaul (MRO) should organise the idea evaluation process as part of the front-end of innovation (FEI). Therefore, the following main research question was specified:

How can innovative ideas be assessed and selected by aviation-Maintenance Repair and Overhaul firms to speed up the overall innovation process?

SQ1 This research examines the idea evaluation process as part of the FEI. This process is located at the beginning of the innovation process and often incorporates a fixed structure and evaluation criteria to evaluate and prioritise innovative ideas.

SQ2 An extensive literature review provided three idea evaluation models that could potentially be utilised as the starting point for the framework. Additionally, the literature review pinpointed the importance of three criteria for the first evaluation and 17 for the second evaluation.

Furthermore, twelve semi-structured interviews with MRO experts revealed that seven of the twelve organisations utilise a stage-gate approach, incorporating some slight variations. The interviews also added 11 additional evaluation criteria, which were not found in the literature.

SQ3 Afterwards, an expert survey was utilised to transfer the generic criteria into industry-specific criteria with the help of twelve innovation experts working in an MRO organisation. The survey uncovered that five criteria were relevant to assess during the initial screen: Strategic fit, Customer Need, Value Proposition, Return on Investment, and Acceptance of the workforce. Additionally, the innovation experts revealed that 14 criteria are deemed relevant to evaluation during the preliminary evaluation in the context of aviation-MRO. The criteria are Customer Satisfaction, Competitive Advantage, Customer Need, Strategic Fit, Usability, Value Proposition, Technical Feasibility, Legal Feasibility, Operational Feasibility, Financial Feasibility, Synergy, Time to market, Return on Investment, and Acceptance of the workforce. The following framework was designed when combining the key learnings from the literature review, semi-structured interviews, and the MRO expert survey (Figure 19).

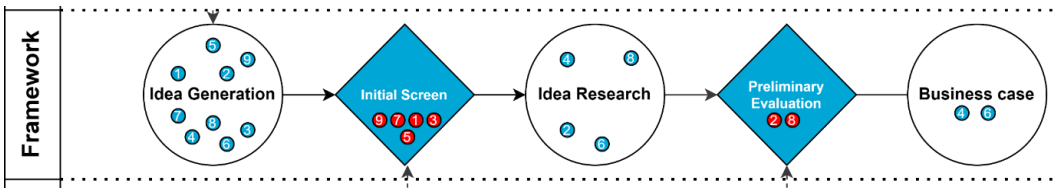


Figure 19: Idea Evaluation Framework

SQ4

The framework above proposes the process flow and evaluation criteria, which can be used as the foundation for establishing the idea evaluation process. Hence, a case study was utilised to understand how the organisation's context impacts the framework. One can mention that the framework's structure remained the same within the organisational context of KLM E&M as the framework's steps persisted. However, the organisational context significantly impacted the evaluation criteria (Figure 20).

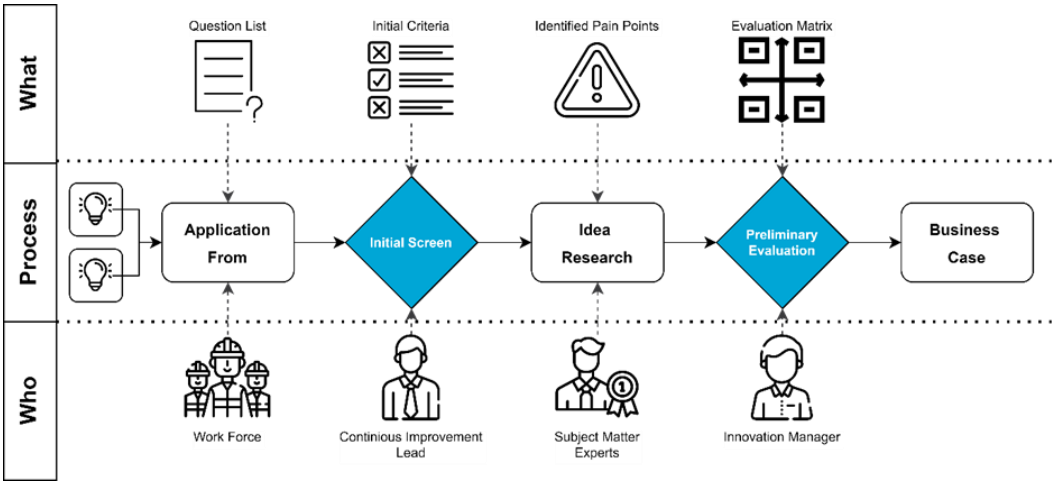


Figure 20: Idea Evaluation Process KLM E&M

Therefore, it can be mentioned that the idea evaluation framework can function as the foundation for establishing the idea evaluation process. However, when implementing the framework, there is no one-size-fits-all method for evaluating ideas, and each organisation should individually determine the criteria that are deemed relevant for their organisation.

MRQ

To conclude, aviation-MRO organisations can utilise the proposed framework within this research as the foundation for establishing the structure of the process and the complete set of evaluation criteria, which need to be trailered towards the specific organisational needs. The framework provides a more transparent and formalised process for both the idea generators and idea evaluators, which results in (1) less repetition of tasks when idea generators are aware of the submitted ideas and evaluation criteria. Subsequently, (2) it reduces the time to complete the evaluation process as idea evaluators possess predefined idea evaluation criteria and a process, in combination with a network of known experts, that can be utilised to obtain the required information. Hence, both factors are contributing to a potential enhancement of the speed during the innovation process resulting in higher innovative throughput and likely an increased sustainable operation for MRO organisations.

BIBLIOGRAPHY

Aagaard, A. (2015). Key differences and similarities in ways of managing and supporting radical pharmaceutical front end innovation - A case study of the pharmaceutical industry. *International Journal of Innovation Management*, *19*(1). https://doi.org/10.1142/S1363919615500115

AAR. (2022). *MRO - Aviation Services | AAR Corporate*. Web Page. https://www.aarcorp.com/mro/

Adhabi, E. A. R., & Anozie, C. B. L. (2017). Literature Review for the Type of Interview in Qualitative Research. *International Journal of Education*, *9*(3), 86. https://doi.org/10.5296/ije.v9i3.11483

Air France KLM E&M. (2020). *EPCOR - Home*. Web Page. https://www.afiklmem.com/en/epcor/epcor-home

Air France KLM E&M. (2022). *AFI KLM E&M - Key Figures*. Website. https://www.afiklmem.com/en/about/key-figures

Air France KLM Group. (2022). *Air France Industries KLM Engineering & Maintenance | Air France KLM*. Web Page. https://www.airfranceklm.com/en/air-france-industries-klm-engineering-maintenance

Airbus NL. (2022). *Maak kennis met AirbusDS.nl - Airbus Defence & Space Dutch Technology*. Web Page. https://www.airbusdefenceandspacenetherlands.nl/nl/over-ons/maak-kennis-met-airbusds-nl/

Airbus Scale. (2022). *Airbus Scale - Innovation Ecosystem - Airbus*. Web Page. https://www.airbus.com/en/innovation/innovation-ecosystem/airbus-scale

Al-kaabi, H., Potter, A., & Naim, M. (2007). An outsourcing decision model for airlines' MRO activities. *Journal of Quality in Maintenance Engineering*, *13*(3), 217–227. https://doi.org/10.1108/13552510710780258

Ayeni, P., Baines, T., Lightfoot, H., & Ball, P. (2011). State-of-the-art of "Lean" in the aviation maintenance, repair, and overhaul industry. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, *225*(11), 2108–2123. https://doi.org/10.1177/0954405411407122

Azapagic, A., & Perdan, S. (2011). *Sustainable Development in Practice Case Studies for Engineers and Scientists Second Edition Editors*.

Barczak, G., Griffin, A., & Kahn, K. B. (2008). *PERSPECTIVE: Trends and Drivers of Success in NPD Practices: Results of the 2003 PDMA Best Practices Study*. https://doi.org/https://doi-org.tudelft.idm.oclc.org/10.1111/j.1540-5885.2009.00331.x

Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Management Decision*, *47*(8), 1323–1339. https://doi.org/10.1108/00251740910984578

Barfield. (2022). *Barfield - MRO Services*. Web Page. https://www.barfieldinc.com/en/services-and-offers/mro-services

Barnes Aerospace. (2022). *Aircraft Component Maintenance Repair and Overhaul (MRO)*. Web Page. https://www.barnesaero.com/our-core-business/maintenance-repair-and-overhaul-mro/

Belliveau, P., Associates, P. B., Griffin, A., & Somermeyer, S. (2002). *The PDMA ToolBook 1 for New Product Development* (First Edition). Wiley.

Boeing. (2022). *Boeing: The Boeing Company: General Information*. Web Page. https://www.boeing.com/company/general-info/index.page

Bows-Larkin, A., Mander, S. L., Traut, M. B., Anderson, K. L., & Wood, F. R. (2016). Aviation and Climate Change-The Continuing Challenge. In *Encyclopedia of Aerospace Engineering* (pp. 1–11). John Wiley & Sons, Ltd. https://doi.org/10.1002/9780470686652.eae1031

British Airways. (2022). *British Airways - Engineering - AOG and Material Services*. Web Page. http://www.ba-mro.com/baemro/aogMaterialServices.shtml

CAPA. (2022). *GMF AeroAsia MRO Profile | CAPA*. Web Page. https://centreforaviation.com/data/profiles/maintenance-repair-and-overhaul/gmf-aeroasia

Carbonell-Foulquié, P., Munuera-Alemán, J. L., & Rddríguez-Escudero, A. I. (2004). Criteria employed for go/no-go decisions when developing successful highly innovative products. *Industrial Marketing Management*, *33*(4), 307–316. https://doi.org/10.1016/S0019-8501(03)00080-4

Chanaron, J. J., Tovstiga, G., & Hillenbrand, C. (2011). Innovation performance measurement: current practices, issues and management challenges. In *Int. J. Technology Management* (Vol. 56, Issue 1).

Chionce, N. E., & van der Veen, R. G. W. (2001). *Introduction to Focus Groups*. Web Page. https://metodix.fi/2014/05/17/van-der-veen-focus-groups/

Christensen, C., Kaufman, S., & Shih, W. (2010). *Innovation Killers: How Financial Tools Destroy Your Capacity to Do New Things*. Harvard Business Review Press.

Cooper, R. (1983). A Process Model for Industrial New Product Development. In *IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT* (Vol. 30, Issue 1).

Cooper, R. (2011). *Winning at New Products Creating Value Through Innovation* (4th ed.). Basic Books.

Cooper, R. G. (1988). Predevelopment Activities Determine Product Success. In *Industrial Marketing Management* (Vol. 17).

Cooper, R. G. (1994). Third-Generation New Product Processes. *Journal of Product Innovation Management*, *11*(1), 3–14. https://doi.org/10.1111/1540-5885.1110003

Cooper, R. G. (2010). *the Stage-Gate idea to launch system 1*.

CTS Engines. (2022). *About CTS – CTS Engines*. Web Page. https://ctsengines.com/about-cts/

Cui, A. S., & Wu, F. (2017). The Impact of Customer Involvement on New Product Development: Contingent and Substitutive Effects. *Journal of Product Innovation Management*, *34*(1), 60–80. https://doi.org/10.1111/jpim.12326

Dziallas, M. (2020). How to evaluate innovative ideas and concepts at the front-end?: A front-end perspective of the automotive innovation process. *Journal of Business Research*, *110*, 502–518. https://doi.org/10.1016/j.jbusres.2018.05.008

Eling, K., & Herstatt, C. (2017). Managing the Front End of Innovation—Less Fuzzy, Yet Still Not Fully Understood. In *Journal of Product Innovation Management* (Vol. 34, Issue 6, pp. 864–874). Blackwell Publishing Ltd. https://doi.org/10.1111/jpim.12415

Ellwood, P., Grimshaw, P., & Pandza, K. (2017). Accelerating the Innovation Process: A Systematic Review and Realist Synthesis of the Research Literature. *International Journal of Management Reviews*, *19*(4), 510–530. https://doi.org/10.1111/ijmr.12108

Gassmann, O., & Schweitzer, F. (2013). Managing the unmanageable: The fuzzy front end of innovation. In *Management of the Fuzzy Front End of Innovation* (pp. 3–14). Springer International Publishing. https://doi.org/10.1007/978-3-319-01056-4_1

Gaubinger, K., Rabl, M., Swan, S., & Werani, T. (2015). *Springer Texts in Business and Economics Innovation and Product Management A Holistic and Practical Approach to Uncertainty Reduction*. http://www.springer.com/series/10099

GKN Aerospace. (2022). *Fokker Technologies | GKN Aerospace*. Web Page. https://www.gknaerospace.com/en/about-gkn-aerospace/fokker-technologies/

GMF AeroAsia. (2022). *GMF - About us*. Web Page. https://www.gmf-aeroasia.co.id

Goffin, K., & Mitchell, R. (2017). Understanding Innovation and Innovation Management. In *Innovation Management: Effective strategy and implementation* (pp. 1–40). Macmillan Education UK. https://doi.org/10.1057/978-1-137-37344-1_1

Goncalves, C. ;, & Kokkolaras, M. (2017). Modeling the relationship between aviation original equipment manufacturers and maintenance, repair and overhaul enterprises from a product-service system perspective. *Conference on Engineering Design*, *3*.

Grewe, V., Gangoli Rao, A., Grönstedt, T., Xisto, C., Linke, F., Melkert, J., Middel, J., Ohlenforst, B., Blakey, S., Christie, S., Matthes, S., & Dahlmann, K. (2021). Evaluating the climate impact of aviation emission scenarios towards the Paris agreement including COVID-19 effects. *Nature Communications*, *12*(1). https://doi.org/10.1038/s41467-021-24091-y

Haarmans, B. (2020, April 5). *Waarom innovatie alleen gaat vliegen als je medestanders hebt - innovatielessen van Transavia*. Avanteers. https://avanteers.nl/podcast/innovatietransavia/

HAECO. (2020). *HAECO – About HAECO*. Web Page. https://www.haeco.com/en/About-HAECO/About-Us

Haeco ITM. (2022). *HAECO – HAECO ITM – About Us*. Web Page. https://www.haeco.com/en/HAECO-Group/HAECO-ITM/About-Us

Hoonsopon, D., & Puriwat, W. (2021). The role of leadership behaviour of project manager in managing the fuzzy front end in the development of radical and incremental innovation.

International Journal of Innovation Management, *25*(2). https://doi.org/10.1142/S1363919621500225

Huang, F., & Rice, J. (2012). Openness in product and process innovation. *International Journal of Innovation Management*, *16*(4). https://doi.org/10.1142/S1363919612003812

Hve. (2020). *Hangar 14 KLM in samenwerking met EversPartners en Solarstell - HVE*. Web Page. https://www.hve-nl.com/portfolio/hangar-14-klm-in-samenwerking-met-everspartners/

JetSupport. (2022). *About us – JetSupport*. Web Page . https://jetsupport.aero/about-us/

Kennedy, R. (2020). *Strategic Management*. Virginia Tech Publishing. https://doi.org/https://doi.org/10.21061/strategicmanagement CC BY NC-SA 3.0

Kennel, V., Reiter-Palmon, R., de Vreede, T., & de Vreede, G. J. (2013). Creativity in teams: An examination of team accuracy in the idea evaluation and selection process. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 630–639. https://doi.org/10.1109/HICSS.2013.153

Kessler, E. H., & Bierly, P. E. (2002). Is faster really better? An empirical test of the implications of innovation speed. *IEEE Transactions on Engineering Management*, *49*(1), 2–12. https://doi.org/10.1109/17.985742

Kim, J., & Wilemon, D. (2002). Focusing the fuzzy front–end in new product development. *R&D Management*, *32*(4), 269–279. https://doi.org/10.1111/1467-9310.00259

Kinnison, H. A., & Siddiqui, T. (2013). *Aviation Maintenance Management* (L. Hager, Ed.; Second Edition). The McGraw-Hill Companies.

Klaxoon. (2022). *1-2-4 All Methodology*. Web Page. https://klaxoon.com/community-content/1-2-4-all-the-brainstorming-method-used-to-generate-ideas-alone-in-pairs-in-foursomes-then-all-together

KLM Royal Dutch Airlines. (2020). *Annual Report 2020*. https://annualreports.klm.com/

Kock, A., & Georg Gemünden, H. (2016). Antecedents to Decision-Making Quality and Agility in Innovation Portfolio Management. *Journal of Product Innovation Management*, *33*(6), 670–686. https://doi.org/10.1111/jpim.12336

Koen, P. A., Ajamian, G., Boyce, S., Clamen, A., Fisher, E., Fountoulakis, S. G., Johnson, A., Puri, P., & Seibert, R. (2002). *Fuzzy Front End : Effective Methods, Tools, and Techniques*.

Koen, P. A., Bertels, H. M. J., & Kleinschmidt, E. (2014). Managing the front end of innovation-part I: Results from a three-year study. *Research Technology Management*, *57*(2), 34–43. https://doi.org/10.5437/08956308X5702145

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., Elkins, C., Herald, K., Incorvia, M., Johnson, A., Karol, R., Seibert, R., Slavejkov, A., & Wagner, K. (2001). Providing clarity and a common language to the "fuzzy front end." *Research Technology Management*, *44*(2), 46–55. https://doi.org/10.1080/08956308.2001.11671418

Lai, Y. Y., Christley, E., Kulanovic, A., Teng, C. C., Björklund, A., Nordensvärd, J., Karakaya, E., & Urban, F. (2022). Analysing the opportunities and challenges for mitigating the climate impact of aviation: A narrative review. In *Renewable and Sustainable Energy Reviews* (Vol. 156). Elsevier Ltd. https://doi.org/10.1016/j.rser.2021.111972

Lobo, S., & Samaranayake, P. (2020). An innovation management assessment framework. *Benchmarking*, *27*(5), 1633–1656. https://doi.org/10.1108/BIJ-02-2019-0085

Lufthansa Technik. (2022). *Capabilities at a glance*. Web Page. https://www.lufthansa-technik.com/capabilities-at-a-glance

Lüke, K. H., Walther, J., & Wäldchen, D. (2018). Innovation management methods in the aviation industry. *Communications in Computer and Information Science*, *863*, 161–177. https://doi.org/10.1007/978-3-319-93408-2_12

Markham, S. K. (2013). The impact of front-end innovation activities on product performance. *Journal of Product Innovation Management*, *30*(SUPPL 1), 77–92. https://doi.org/10.1111/jpim.12065

Martinsuo, M., & Poskela, J. (2011). *Use of Evaluation Criteria and Innovation Performance in the Front End of Innovation*.

Messerle, M., Binz, H., & Roth, D. (2013). Elaboration and assessment of a set of criteria for the evaluation of product ideas. *INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN*.

MindTools. (2022). *The Action Priority Matrix - Time Management Tools From MindTools.com*. Web Page. https://www.mindtools.com/pages/article/newHTE_95.htm

Newell, S., Morton, J., Marabelli, M., & Galliers, R. (2019). *Managing Digital Innovation* (1st ed.). Bloomsbury Publishing Plc. https://doi.org/https://doi.org/10.26777/978-1-137-43240-7

Ortt, R., & van der Duin, P. (2008). The evolution of innovation management towards contextual innovation. *European Journal of Innovation Management*, *11*(4), 522–538. https://doi.org/10.1108/14601060810911147

Pereira, A. R., Ferreira, J. J. P., & Lopes, A. (2020). A knowledge representation of the beginning of the innovation process: The Front End of Innovation Integrative Ontology (FEI2O). *Data and Knowledge Engineering*, *125*. https://doi.org/10.1016/j.datak.2019.101760

Ratten, V., Ferreira, J. J., & Fernandes, C. I. (2017). Innovation management – current trends and future directions. In *Int. J. Innovation and Learning* (Vol. 22, Issue 2).

Rice, M. P., Kelley, D., Peters, L., & Colarelli O'connor, G. (2002). *Radical innovation: triggering initiation of opportunity recognition and evaluation*. https://doi.org/10.1111/1467-9310.00228

Robbins, P., & O'gorman, C. (2014). *Innovating the innovation process: an organisational experiment in global pharma pursuing radical innovation*.

Rochford, L. (1991). Generating and screening new products ideas. *Industrial Marketing Management*, *20*(4), 287–296. https://doi.org/10.1016/0019-8501(91)90003-X

Rodrigues Vieira, D., & Loures, P. L. (2016). Maintenance, Repair and Overhaul (MRO) Fundamentals and Strategies: An Aeronautical Industry Overview Holds the research chair in Management of Aeronautical Projects Université du Québec à Trois Rivières-Canada. *International Journal of Computer Applications*, *135*(12), 975–8887.

Ryley, T., Baumeister, S., & Coulter, L. (2020). Climate change influences on aviation: A literature review. *Transport Policy*, *92*, 55–64. https://doi.org/10.1016/j.tranpol.2020.04.010

Sahay, A. (2012). *Leveraging Information Technology for Optimal Aircraft Maintenance, Repair and Overhaul* (First Edition). Woodhead Publishing.

Sandmeier, P. ;, Jamali, N. ;, Kobe, C. ;, Enkel, E. ;, Gassmann, O. ;, & Meier, M. (2004). Towards a Structured and Integrative Front-End of Product Innovation Conference Paper. *ETH Library* . https://doi.org/10.3929/ethz-a-010090510

Schilling, M. (2017). *Strategic Management of Technological Innovation*. https://www.mheducation.com/highered/product/strategic-management-technological-innovation-schilling/M9781260087956.html

Schygge, J. (2015). *Proposing a Framework of Preconditions for Idea Adoption: A Case Study Investigating Adoption of Ideas within the Front End of Innovation*. https://doi.org/10.13140/RG.2.1.1365.6169

Scribbr. (2022). *Transcribing an interview in 5 steps*. Web Page. https://www.scribbr.com/methodology/transcribe-interview/

Sekaran, U., & Bougie, R. (2016). *Research Methods for Business* (Sevebth Edition). John Wiley & Sons Ltd. www.wileypluslearningspace.com

Soukhoroukova, A., Spann, M., & Skiera, B. (2012). Sourcing, filtering, and evaluating new product ideas: An empirical exploration of the performance of idea markets. *Journal of Product Innovation Management*, *29*(1), 100–112. https://doi.org/10.1111/j.1540-5885.2011.00881.x

Specto. (2022). *about SPECTO | SPECTO Aerospace*. Web Page. https://www.spectoaerospace.com/about-specto

ST Engineering. (2022). *Aerospace | ST Engineering*. Web Page . https://www.stengg.com/en/aerospace/

Transavia. (2022). *Transavia Corporate | Company profile*. Web Page. https://corporate.transavia.com/en-EU/organisation/company-profile/

TU Delft. (2022). *Educational Tooling: Overview of tools used in education | Teaching & Learning Support*. Web Page. https://teaching-support.tudelft.nl/educational-tooling/

TUI NL. (2022). *TUI Group | TUI Netherlands*. Web Page. https://www.tui.nl/corporate/nl/over-tui/tui-group

van den Ende, J. (2021). *Innovation Management*. Red Globe Press.

Vértesy, D. (2017). Preconditions, windows of opportunity and innovation strategies: Successive leadership changes in the regional jet industry. *Research Policy*, *46*(2), 388–403. https://doi.org/10.1016/J.RESPOL.2016.09.011

WIPO. (2015). *World Intellectual Property Report Breakthrough Innovation and Economic Growth*. https://www.wipo.int/publications/en/details.jsp?id=3995

Zonta, T., da Costa, C. A., da Rosa Righi, R., de Lima, M. J., da Trindade, E. S., & Li, G. P. (2020). Predictive maintenance in the Industry 4.0: A systematic literature review. *Computers & Industrial Engineering*, *150*, 106889. https://doi.org/10.1016/J.CIE.2020.106889

LIST OF APPENDICES

APPENDIX I: EVALUATION CRITERIA

This appendix presents all the evaluation criteria considered in the literature review. A total of sex literature studies were deemed relevant and were examined to compile the table below[3].

Rochford, 1991	Belliveau et al., 2002	Dziallas, 2020	Carbonell-Foulquié et al., 2004	Gaubinger et al., 2015	Messerle et al., 2013
Market					
Size (current and potential)	Strategic Leverage	Customer satisfaction	Window of opportunity	Market volume	Market Potential
Growth (current and potential)			Market acceptance	Market growth	Fit with trends
Appeal			Customer Satisfaction	Competitive situation	Entry barriers
Role for the company			Long-term sales growth	Market share	Sustainable/competitive advantage
			Market Share	Suitability of distribution system	
Product					
Uniqueness	Strategic Fit	Degree of Innovation	Strategic Fit	Quality	Product performance
Exclusivity (Patentability)		Degree of Novelty	Quality	Flexibility	Fit with Strategy
Strategic Fit		Extension of product portfolio		Reliability	
		Innovation quality			
Feasibility					
Product development	Commercial success probability	Technical feasibility			Technical feasibility
Technology	Technical success probability				Availability of technical resources
Production					Availability of human resources
Personnel					
Financial					
Compatibility					
Organisational Infrastructure		Synergy		Personnel and spatial capacities	Synergy
Personnel and managerial experience and expertise (Marketing)				Demands on challenges for employees	Existence of necessary infrastructure
Personnel and managerial experience and expertise (Sales)				Demands on challenges for workplace security	
Personnel and managerial experience and expertise (Technical)				Demands on challenges for qualification	
Personnel and managerial experience and expertise (Production)				Familiarity	
Personnel and managerial experience and expertise (Financial)					
Personnel and managerial experience and expertise (Customer/market needs)					
Time					
Needed to develop the idea		Time to Market		Duration of the innovation process	
Needed to commercialise				Duration of market introduction	
Financial					
Investment requirements	Reward	Economic efficiency	Margin rate	Cash flow	Comparison of profit and costs
Costs			IRR	ROI	Availability of Financial resources
Profitability			Sales volume	Profit	
				Costs	
				Turnover	
				Capital expenditure	
Other					
Gut Feel		Communication Potential		Ecological impact	Legal restrictions
Is it realistic		Sustainability		Legal consideration	Political environment
Probability of success					Existing patents

[3] (Belliveau et al., 2002; Carbonell-Foulquié et al., 2004; Dziallas, 2020; Gaubinger et al., 2015; Koen et al., 2002; Messerle et al., 2013; Rochford, 1991)

APPENDIX II: MRO ORGANISATIONS

This appendix is used to classify MRO organisations based on their maintenance capabilities and organisational structure. The following sources are used to compile the table below (AAR, 2022; Air France KLM E&M, 2020; Air France KLM Group, 2022; Barfield, 2022; Barnes Aerospace, 2022; British Airways, 2022; CTS Engines, 2022; GKN Aerospace, 2022; HAECO, 2020; Lufthansa Technik, 2022; ST Engineering, 2022).

Name	Logo	Description	Maintenance Capabilities	Organisational Structure
HAECO		One of the larger MRO organisations in terms of capacity. Through 16 companies, they offer a full spectrum of services.	Airframe Services, Component Services, Line Services, Engine Services, Freighter conversion, Modifications, and Fleet technical management	Independent E&M organisation
AFI KLM E&M		Second largest MRO based upon revenue. Having a network of 200 customers, they offer a variety of services	Airframe Services, Line Services, Component Services, Engine Services, and Aircraft Modifications.	Airline-MRO, as part of the AFI KLM group
AAR		Largest MRO organisation within North America. A total of 33 companies worldwide are providing an array of services to customers.	Airframe Services, Line services, Component Services, and Aircraft Modifications.	Independent E&M organisation
ST Engineering		Largest airframe MRO solution provider, specialised in engine nacelle and composite panels.	Airframe Services, Component Services, Engine Services, Freighter conversion, Modifications, and Asset technical management	Independent E&M organisation
Barnes Aerospace		An industry leader in the maintenance of turbine engines. They offer both in-house repair and manufacturing solutions.	Engine Services	Independent E&M organisation
GKN Aerospace / Fokker		A previous OEM, which evolved into a full-service MRO provider for component and aircraft maintenance and overhaul	Airframe Services (heavy maintenance), Aircraft modifications, Component Services, and Aircraft painting services	Independent E&M organisation
Hawker Pacific Aerospace		An MRO organisation that is specialised in landing gears, including the associated hydraulic components	Component Services	Airline-MRO, as a subsidiary of Lufthansa Technik
Lufthansa Technik		An airline-MRO providing maintenance for Lufthansa and third parties. Providing services for 26 types of aircraft, making it one of the largest MROs in terms of aircraft services	Airframe Services, Line Services, Component Services, Engine Services, Modifications, Composite repairs, and Fleet technical management	Airline-MRO, as part of the Lufthansa group
British Airways Engineering		An MRO organisation that both provides maintenance on the larger airports in the UK, and specialised services in Glasgow and Cardiff	Airframe Services, Line Services, Component Services, Engine Services, Modifications, and Aircraft painting Services	Airline-MRO, as part of the British Airways
EPCOR		An airline-owned MRO specialised in axillary power units and associated components	Component Services	Airline-MRO, as a subsidiary of AFI KLM group
CTS Engines		Global leader in engine services, serving both commercial and military customers	Engine Services	Independent E&M organisation
Barfield		This MRO has the capabilities to test, repair and overhaul 25000 parts, ranging from avionics to hydraulics/electronics	Component Services	Airline-MRO, as a subsidiary of AFI KLM group

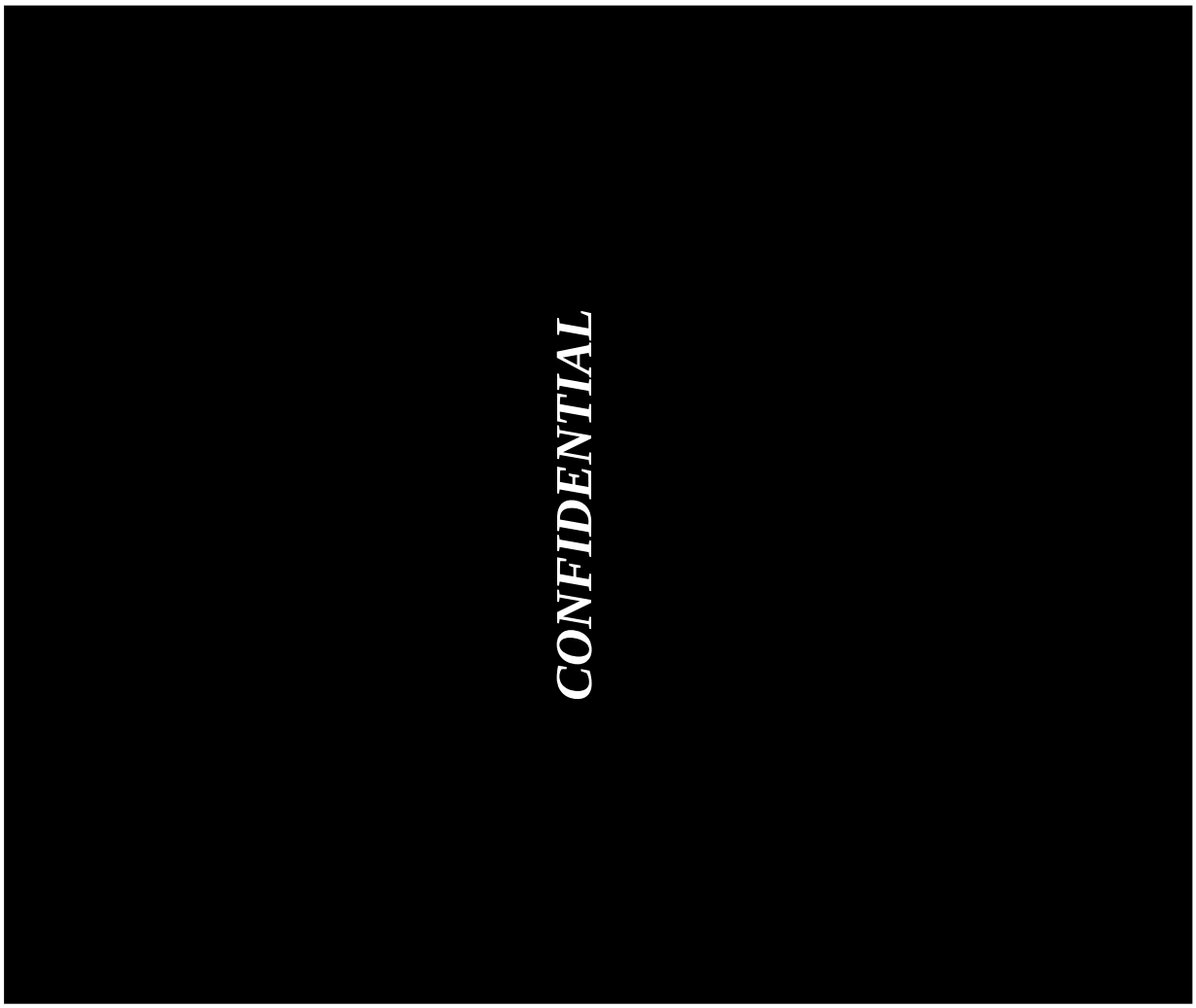
APPENDIX II: FRAMEWORK INTERVIEWS

This appendix includes 12 interviewees to reveal the idea evaluation processes and criteria within the MRO industry and directly related organisations. For more information, the name of the organisation can be selected.

Epcor	A Dutch-based Auxiliary Power Unit and component specialist. They provide MRO services as part of the AFI KLM group (Air France KLM E&M, 2020).
Transavia	Transavia is a budget airline and part of the AFI KLM group. Besides, they also have an integrated maintenance division (Transavia, 2022).
Boeing Global Services	Boeing Global Services provides innovative and cost-competitive services for its customers as one of the three business units. (Boeing, 2022).
JetSupport	JetSupport is an independent (Dutch) MRO provider offering a range of services, such as components, airframe, and engines (also APU) (JetSupport, 2022).
Haeco ITM	Haeco is one of the largest independent MRO service providers, consisting of 16 companies worldwide. Haeco ITM provides technical inventory management (Haeco ITM, 2022).
ST Engineering	As the world's largest airframe MRO, ST Engineering can work on 94 aircraft simultaneously, divided over different facilities (ST Engineering, 2022).
TUI NL	TUI NL is part of the TUI group, which operates five different airlines, incorporating a fleet of roughly 150 aircraft (TUI NL, 2022).
Fokker	As part of GKN Aerospace, Fokker incorporates multiple Dutch divisions, such as Elmo (electrical wiring) and Landing gear (GKN Aerospace, 2022), making them an independent specialised MRO.
Specto	Specto is an independent MRO offering multiple composite- and sheet metal repair solutions. They perform repairs on fixed-wing and helicopter structures in the Netherlands (Specto, 2022).
Airbus Scale	Airbus scale is the internal accelerator of Airbus by fostering innovations with the help of start-up engagement. They identify and develop organisational innovations (Airbus Scale, 2022).
Airbus NL	Airbus NL is focused on military and space applications, as they are a sub-division of Airbus (Airbus NL, 2022).
Air France E&M	Air France and KLM have merged their maintenance into AFI KLM E&M, which makes them one of the leading MROs around the globe (Air France KLM E&M, 2022)

CONFIDENTIAL (TO BE REMOVED IN THE PUBLISHED VERSION)

This section cannot be published and is only relevant to the university assessment of this research. Please note that the interviews' names and functions are confidential and cannot be shared or externally stored.



Interview 1: Epcor

Date	05-04-2022
Interview Duration	00:52:32
Interview Type	Semi-Structured
Location	Schiphol – Rijk
Interviewee	Epcor employee **Confidential**
Reviewed by Interviewee	Yes, on 07-04-2022

How does your organisation approach innovation? (The purpose of the company)?

Innovation is located in the core strategy of Epcor, called "Continuous improvement". "Being the best MRO Shop for auxiliary power units" (APUs).

Epcor has established a "10 to team" process, referring to the 10 euros rewarded to a department for every successful innovation developed within Epcor. Additionally, every month, a preselected jury (including people from different departments) picks the best idea of the month, which earns 200 euros for the department. The money can be spent on team building or other team activities.

Epcor uses a planner per department to track their innovations and classify them into three categories: (1) Just-do-its, small changes very simplistic, (2) Improvements, (3) projects, more extensive projects involving long-term changes and actions. These classifications are defined based on the quality & financial impact of the idea. The reason for using the planner is that they can assign people to specific ideas and track the generated ideas' progress. When ideas are added to the planner, the team's supervisor presents the idea in the operations meeting with the supervisors and operational manager.

What processes and tools do you use to preliminarily assess innovations and select the most promising ideas?

When the idea is generated or an opportunity is discovered within Epcor, the first assessment happens with the direct supervisor. He/she uses their experience to assess the feasibility of this idea to determine whether it is worth pursuing. When approved, the idea is added to the planner described above and presented by the supervisor in the operational meeting. This meeting includes all supervisors from the different departments and the operational manager, who then decides whether the innovative idea will be continued. After the ops meeting, "Just do its" & "Improvements" will be managed by the shop supervisors. Projects that need higher financials are developed into business cases. These business cases will then be presented at the management level. After approval, these projects are managed by supervisors with the help of stakeholders (primarily engineers).

How does your organisation select one (or multiple) out of several ideas?

As mentioned above, the direct supervisor performs the first selection, and the second selection is completed during the operational meeting with all the supervisors and the operational manager.

What are some crucial aspects when creating an ideation framework based on your experience?

An organisation, especially within an operational environment, must be willing to ensure a budget and human resources to pursue innovation. Significantly since the pressure on the operational environment can vary, it is essential to have considered this when creating an innovative process.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems (internal IT and external third parties)?

Due to COVID, the production environment is not as busy as a few years ago, allowing Epcor to assign employees to the shop floor. However, when demand for APU maintenance rises, Epcor prepared a new function called ‘’technical coordinator‘’, which will not be directly included in the production environment. However, this employee will spend most of the time on the shop floor as shop employees' direct point of contact. Currently, this function is not live due to the lowered demand in aviation.

Epcor assigns a dedicated part of the budget for innovation, as they also can assign shop employees to "improvement". Epcor promotes that being a shop employee means operational tasks and working on improving the process at Epcor. Although a lower average age generally makes it easier to change behaviour, it is also how Epcor approached improvements that stimulate innovation.

Interview 2: Transavia

Date	31-03-2022
Interview Duration	47:37
Interview Type	Semi-Structured
Location	Online
Interviewee	Transavia employee **Confidential**
Reviewed by Interviewee	Yes, on 08-04-2022

Interview Preparation:

Brit Haarmans, Transavia - Waarom innovatie alleen gaat vliegen als je medestanders hebt (Haarmans, 2020).

The innovation Lab started in 2019. As mentioned in the podcast, Transavia stimulates employees to innovate and provides guidance for innovative initiatives and projects (What technologies are in the market, outside aviation, horizon 3). One innovative trial that Transavia has already tried is determining the weight of passengers at the gate to better estimate the plane's weight and accurately calculate the required fuel and fuel burn. When trying to implement this idea, they faced problems with the scalability in terms of equipment needed and the regulations, which mandate a specific way of performing weight calculations.

Transavia Ventures (started in 2019) is a separate company with its budget and primarily invests in external or internal companies focussing on horizon 2&3 innovation (sometimes 1). Transavia has organised its Innovation Lab with multiple members in different parts of the organisation, each having a part-time function at the innovation lab (roughly 40% of their time). They are the innovation champions within the organisation and help stay in close contact with its core business instead of completely detaching It. The operational environment makes it difficult as they also have other schedules.

Interview

How does Transavia approach innovation? (The purpose of the company).

The Innovation Lab has recently reshifted its focus from pursuing the generation of new ideas within the organisation to supporting the central organisation. Transavia noticed that collaboration and tolerability were limited when pushing new technologies to be implemented on the work floor.

Additionally, Transavia Ventures is investing in start-ups. Some of these are directly relevant to the core business of Transavia. However, horizon three innovation is considered within the ‘’Sustainability Circle’’. This initiative consists of multiple employees from across the company. They are creating ambitions for the future of Transavia and potential new technologies (such as Electric flying) that might become relevant in the future.

What processes and tools do you use to preliminary assess innovations to select/filter promising ideas?

As problems are developed locally, with the help of specific departments and direct management, there is no pre-defined preliminary idea/problem evaluation process.

How does Transavia select one (or multiple) out of several ideas?

Within Transavia, the innovation process nearly always starts with an identified problem. Although it is also possible to start with opportunities, it is more challenging to pursue ideas with a lack of a problem (or problem owner) generally creates less tolerability across the organisation.

Therefore, new ideas are not directly competing in the first phase. However, Transavia needs to assess which business case they will invest in, but this is done with the help of an innovation consultant, who is considering both the problem and the innovative solution. Afterwards, the management needs to approve the idea, as there is currently no pre-defined budget for innovation.

How does Transavia ensure that new ideas survive the "innovation chasm" and move to the next phase (to develop them into a business case)?

When employees on the shop floor have identified a problem, they are allowed to describe it and think of a solution. This is essential as they have the most experience with the problem. Afterwards, employees go to their direct managers to discuss the problem, which they can research themselves (if approved). Therefore, the initial development stages are decentralised. Although it would be beneficial to have a central registration (knowledge centre) of all projects, it is preferred to leave the development within the specific departments.

Furthermore, the network of the Innovation team members is used to communicate with other departments within the organisation to share information regarding a newly developed business case. Although this does not reach all aspects of the organisation inherent to a large organisation, there is currently no standardised method or communication process.

How does Transavia develop business ideas with limited knowledge and information?

As innovations originate from a problem, which is locally developed, there is not a central idea assessment system. Therefore, Transavia is critically examing the business case, also using Transavia Ventures to match start-ups with problems within Transavia. Additionally, they are working with partners, such as KLM and Schiphol, to develop together (for instance, the cooperation with Mainblades and KLM).

How does Transavia overcome key challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems (internal IT, internal business, external third parties)?

Transavia does not have a fixed budget for innovation, there initially was a plan to have a fixed budget for innovation, but due to COVID-19, this was cancelled. Additionally, people's capacity is problematic, as they have minimal time to spend on innovation. Part-time functions related to innovation have nearly half of the time for innovation. However, this depends on the operational environment (limited operational capacity directly impacts the innovation time).

What is an AB-Test?

The AB-test is used to assess the willingness of passengers to use a particular idea or how often passengers are using the new idea. (E.g. ordering online meals before the flight). Transavia would give half of the passengers access to the new applications, while the other group would be the control group to discover the correlation between the group. By utilising this methodology, Transavia can assess passengers' willingness and the added value of the newly introduced idea/application.

Interview 3: Boeing Global Services

Date	11-04-2022
Interview Duration	00:34:30
Interview Type	Semi-Structured
Location	Online
Interviewee	Boeing Global Services employee **Confidential**
Reviewed by Interviewee	Yes, on 26-04-2022

This interview is exclusively focused on the Boeing global services business unit, as one of three business units within Boeing. Therefore, this interview does not describe the innovation process within Boeing. However, it is geared towards the R&D department.

How does your organisation approach innovation? (The purpose of the company)

Within the R&D department, the Product Research and Incubation team is the innovation hub where the generated ideas follow a predetermined process. The innovation process uses a crowdsourcing approach, where employees can upload their ideas via a one-pager. On this platform, all employees can reply to or support uploaded ideas.

The process is organised in a ‘’Pipeline’’ setup, where the ideas are generated and ranked every four months on one side of the pipeline. As this team works in an agile environment, they use a time interval of four months for all their projects. Additionally, a pool of researchers is used, who are also changing projects every four months based on the needs of every project.

Furthermore, a 24-hour jam session is organised where employees are assigned to a team of roughly three people and aim to create an initial business model / identify opportunities and barriers for three already generated ideas within the pool. The ideas are ranked based on their score and pitched in a Shark Tank format. The overall best ideas will boost their development, which also depends on the team's capacity. For instance, this determines the number of ideas that can be further developed.

The development process is based on a stage-gate process, where the researchers are either convinced the idea has potential or not after four months. However, despite their conclusions, they need to present the idea in a shark tank

scenario. This is called the ‘’gate’’, where relevant stakeholders assess the idea. Specific criteria need to be matched during this presentation, such as (1) emphasising the value proposition, (2) go-to-market strategy, and (3) technical feasibility. Based on this presentation, the idea either passes or fails the gate.

When an idea fails, it is stored in a ‘’garbage bin’’. When an idea passes the gate, it will be handed over to a new team, which will use a ‘’development pipeline’’ (slightly more tools and different resources, such as business and technical specialists). After four months, they have another gate incorporating slightly stricter requirements. Next, the final development phase prepares the project to enter the market or be implemented within a specific team.

What processes and tools do you use to preliminary assess innovations to select the most promising ideas?
Specific criteria are used to assess ideas before the development phase is started. The criteria are (1) potential return on investment, (2) technical feasibility, (3) potential competitors, (4) Strategic alignment, (5) competitive advantage, (6) definition of the project vision. However, the number one criterion is to examine the customer need for the idea (it can be internal and external customers). The business model canvas and empathy map are used in terms of tools to create a good overview of the idea and highlight customer pain points.

However, this process is not hard-coded based on the evaluation criteria. There is also some vagueness to the process, where it can be challenging to assess the criteria objectively. This is not necessarily a requirement; however, portfolio ownership is essential for developing a project. When there is no portfolio willing to take ownership of the project, it is decremental for the project's development.

How is the actual assessment of ideas organised? Are there multiple experts involved?
The communications team is in charge of this process and responsible for collecting ideas. The assessment of experts is usually the same and consists of multiple people from senior leadership, for instance, a portfolio officer.

How does your organisation test business ideas with limited information or knowledge?
Currently, roughly 200 ideas are in the backlog pool, where they can run 10-12 ideas over a year. Although an idea is assessed throughout the jam sessions, an idea could be not worth devoting resources. Therefore, a preliminary gate is implemented to assess the idea again after two weeks of development. Ideas can be killed immediately, and not the entire four months are devoted to them. For instance, ideas can be in the pool for extended periods, impacting whether or not the idea is still relevant for further development.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?
This does not apply to this case as the department is within an R&D setting. The daily operation is research and development. However, they are limited to working on new-new projects (only be relevant in 5 years). Therefore, they have set up research ‘thrust lead’’. These projects are not changed every four months and are aimed to focus on new-new projects.

How do you ensure that ideas move from one development pipe to the subsequent development pipe?
Being unsure at the gate is tricky; however, especially in the first phase (research phase), an educated guess can be sufficient when supported by evidence. However, more evidence and research are needed to pass the gate when further developing the idea.

Interview 4: JetSupport

Date	12-04-2022
Interview Duration	00:48:12
Interview Type	Semi-Structured
Location	Online
Interviewee	JetSupport employee **Confidential**
Reviewed by Interviewee	Yes, on 14-04-2022

How does your organisation approach innovation? (The purpose of the company)

The innovation process within JetSupport is organised as follows.

Idea Submitted: Problems experienced by employees can be submitted in the "Ideeenbox", where employees need to fill in general information, such as (1) what are three potential solutions, (2) What part of the organisation is affected by the problem/idea, (3) who is the problem owner, and (4) what will be the result of the idea (Reduce costs, prevent incidents)? Once the form is submitted, the idea is posted on Yammer, where every organisation employee can react and share their experiences and thoughts. Simultaneously, the idea is moved to Trello and assigned to the ‘’submitted ideas’’ box. Trello is used to track the status of the ideas and communicate this across the whole organisation.

Idea Review: the idea is reviewed by utilising internal experts. Within the phase, employees could react to this idea and share their experiences, not pursuing it. Additionally, departments associated with the idea are asked to critically examine the idea (one suggestion was using different aircraft towing equipment, which was assessed by employees possessing experience with aircraft towing). Moreover, when applicable, an assessment of the regulations is also performed to ensure the idea is not hindered by regulations (often performed by the quality manager or legal department).

Finance: This step is not always required, as this becomes relevant when more significant amounts of money are required to pursue the idea. Before continuing to the next phase, the finance department provides its approval.

In Progress: This phase includes ideas currently being tested and implemented within the organisation.

Completed/Feedback: These are the final phases of the process where completed projects are placed and are awaiting feedback. These projects are moved back into ‘’in progress’’ when feedback needs to be incorporated into the idea.

Note: Apart from the phases described above, sub-descriptions can be attached to the idea to describe the current idea status more detailedly. For instance, when an idea is categorised as ‘’in progress’’, the subheader can be ‘’awaiting manpower’’. This makes it transparent for all employees to understand the current status of ideas.

What processes and tools do you use to preliminary assess innovations to select the most promising ideas?

JetSupport mainly uses internal expertise and employee responses to assess the feasibility and usability of generated ideas. As previously described, other employees can respond to the generated ideas and share their

thoughts, which usually originate from their experiences. Additionally, the innovation team ensures that associated employees with experience in the area impacted by the idea are asked for their vision of the idea.

How does your organisation select one (or multiple) out of several ideas?

No specific evaluation frameworks are utilised; however, the process is made transparent with the help of Yammer (idea generation) and Trello (Idea process tracking). Additionally, the whole process is also presented on a TV screen in the canteen of JetSupport, to ensure transparency and involvement of employees. This allows JetSupport to pursue or neglect specific ideas based on internal expertise and employee responses.

How does your organisation test business ideas with limited information or knowledge?

JetSupport is utilising interns to manage the innovation process. They are updating and maintaining the innovation board and performing additional idea reviews. (This could be required when employees are not responding on the Yammer board or when the innovation manager deems it necessary to further investigate an idea before determining whether to pursue it. For instance, interns could ask specific employees their opinion regarding ideas) or perform other tasks to manage the innovation process.

What are some crucial aspects and processes when creating an ideation framework/process based on your experience?

Legislation, roughly 25% of all generated ideas, is not pursued or requires adjustments to be within the regulatory requirements. Therefore, this is an essential aspect of idea evaluation.

Although this is not relevant as evaluation criteria, **transparency** is essential for the complete process. From personal experience, the interviewee mentioned that the involvement of the employees is highly related to the transparency of the process. When employees are unaware of the status of their idea or why it is not implemented, it does not stimulate involvement.

The operational environment, this aspect influences the time for innovations. As daily operations are prioritised over the innovation process, it could be challenging to arrange a time for employees to generate or develop innovative ideas.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems (internal IT, internal business, external third parties)?

Although JetSupport thought about a reward, it is challenging to classify ideas. When this is based on financial value, small innovations are barely rewarded, although they can be relatively easy. Therefore, they have not implemented a reward system. JetSupport can register hours as "Facilities", which is used for innovation. However, it is challenging to obtain person-hours from the shop floor due to the operational environment. However, the critical aspect is good preparation. When asking for hours with a clear and well-prepared plan, it is easier to convince the planning why time is needed from their staff.

Interview 5: Haeco ITM

Date	13-04-2022
Interview Duration	00:25:22
Interview Type	Semi-Structured
Location	Online
Interviewee	HAECO ITM employee **Confidential**
Reviewed by Interviewee	Yes, on 02-05-2022

HAECO is located in Hong Kong (HQ) and has other facilities across the globe, such as in China and the USA. The main activity of the HAECO group is related to aircraft maintenance (Base and line), but they also offer engine and component support such as Line Replaceable Units and Composites. HAECO ITM is in charge of providing LRU components management support and pooling to its customer.

How does HAECO ITM approach innovation? (The purpose of the company).

This process starts with three aspects. The first one originates from the operations (customer front office or back-office support), where they might face problems or have innovative ideas for their activities. The second aspect is the ‘’prospect’’ of the digital front to identify new opportunities relevant for HAECO ITM. The last would be input from other business units within the HAECO group, which might want to improve their digital front.

Afterwards, they need to prioritise the ideas, where they use criteria such as (1) total costs, (2) return on investment, and (3) the synergy of this idea with other business units.

What process and tools do you use to preliminary assess innovations (idea-evaluation process) to select/filter promising ideas?

HAECO ITM developed a matrix to weigh and prioritise ideas objectively. If you ask the team that came up with the idea whether the idea is critical, the answer would always be definitely. Therefore, the matrix is designed and agreed upon by the management team to create an objective view.

What are the criteria that are stated within the evaluation matrix?

1. Cost-benefit (one of the main criteria)
2. Operational impact (only one team or multiple teams)
3. Timeline (How long it takes to develop)
4. Complexity (a tradeoff between timeline and cost-benefit)

As a shop floor employee, suppose that I have an idea; who is my first point of contact?

If someone on the front line has an idea, he/she can go to the key process owner, the manager or the assistant manager (closer to the actual operation). That person will approach the innovation team to define the idea.

Does the manager or assistant manager have any decision-making authority?

They can decide not to develop the idea further and not contact the innovation team. Therefore, this ‘’step’’ is already a first assessment of the idea.

Does the aviation (MRO) industry impact your criteria?

Yes, definitely. When applying the matrix, assigning weights to the evaluation criteria is essential. For instance, quality and safety would be higher than the timeline.

How does HAECO ITM ensure that before ideas are developed, they are within the boundaries of the regulation?

The team manager should assess this as they know more about the specific regulations than the innovation team. If there are any doubts, the quality department of the HAECO group can also be involved to ensure the regulations are not hampering the idea.

Is there a specific budget for innovation within HAECO ITM?

Yes, a defined budget for innovation (for continuous improvement). When a new application or system (group-wide) is required, this will be outside the budget for continuous improvement, and approval from the management team is required. Once the budget is exceeded, approval from the management is required to continue to pursue new ideas. Within the budget, the innovation team does not require specific approval.

How does HAECO ITM involve employees in the front line in the innovative process?

The key user is always involved in the development process (either the team manager or the person who came up with the idea) to ensure the innovation team does not go off track.

How does HAECO ITM document newly generated ideas?

An internal SharePoint is used so that teams can document and share their ideas. Subsequently, the innovation team can evaluate these ideas following their matrix.

How does HAECO ITM determine the number of ideas selected for further development?

This depends on the innovation team's availability and partners, as they are often involved in innovation projects. For instance, when a project has to be developed internally.

Interview 6: ST Engineering

Date	13-04-2022
Interview Duration	00:32:06
Interview Type	Semi-Structured
Location	Online
Interviewee	ST Engineering **Confidential**
Reviewed by Interviewee	Yes, on 27-04-2022

The specific department of ST engineering is working on automating MRO applications. They are into developing these applications to improve productivity and increase digitalisation. They are working with other business units that perform the MRO process

How is the general innovation process organised within ST Engineering?

When an idea arises on the work floor, they can formally communicate it with the innovation department through their supervisors (also mentioning that this is a significant problem they face). Afterwards, the process diverts into two particular areas. (1) When the problem is relatively straightforward, the business unit will manage the development of the idea (as they also have a continuous improvement team). (2) If the problem is a bit more complicated and requires a higher level of expertise to deploy, the innovation team develops this. As part of the continuous improvement office, they evaluate the value of the job and ensure that the solution matches the demand. This team also evaluates the competing solutions in the market as they do not want to reinvent the wheel.

How are innovative ideas assessed in terms of process and tool?

Within the innovation team, they are mainly focused on assessing the idea's technical feasibility and value. These are the two key considerations. However, other aspects such as usability, the buying of the workforce (acceptance), logistics, and training are also taken into account.

Is it always the case that the supervisor makes the first assessment and you take the second assessment?

The innovation team creates the business case for the idea. However, a specific business unit may present a problem, which might apply to other business units. Therefore, we are also communicating our findings to the business units and management. However, the management and the business unit need to approve before the projects are further developed.

How are you dealing with the limited knowledge and resources at the beginning of the innovation process?

When there is minimal information, the design thinking methodology can initiate the process. The most essential here is to talk to employees on the ground about the operation's pain points. A small-scale proof of concept can also be used to understand the problems and the solution's benefits. So these are some of the strategies you take to reduce the uncertainties.

How do you ensure that you have enough budget and that you have enough human resources in order to sort of test these ideas?

This depends on the kind of project. For instance, developing the robotic system together with that process may be a complete system integration project involving the application and the process engineering portion. So it depends on our assessment and what we will do, and then we plan the projects accordingly.

Is there a specific budget for you over innovation that you can spend on ideas? Is that fixed, or do you need to get approval for each project?

Although there is a budget, we need to get approval for every project.

How does ST engineering deal with the limitations of the operational environment?

The operational environment limits them. However, it is a state of mind rather than the work people need to perform. The good thing is that we have a dedicated team looking at that problem and bringing it forward based on the problem statement for our organisation. So I was talking with you about the third consideration, the human comes into play, that is where a team likes us we go down talking to people trying to understand the real problem and developing the solution I think this is an essential part of the whole innovation process.

How are employees from the shop floor involved in the innovation process?

They expect the innovation team to solve the problem most of the time. However, we are working towards getting them to be more involved because they will be end-users of the solution at the end of the day. So getting them involved is something that we are pursuing at the moment. Yeah, so it has a specific impact on the deployability of the project.

Does the MRO environment hinder ST Engineering from innovating?

Yes, the environment does hinder innovation as it is so highly regulated. Everything needs to be regulated, comparable to the biomedical industry. So whatever they are facing, we also face the same kind of problems. However, if we do not innovate, this industry will fall behind the rest of the world moving forward.

Related to the previous answer, how do you integrate the constraints of regulations into the innovation process?

The innovation team uses the Design for X methodology. The first focus is on the certification/regulation related to the idea. Then after that, you think about the rest of the design methodology so you always have that as the first thing in mind.

Are there any other idea evaluation requirements apart from the matrix?

This is what we have so far. So I think that this is a good enough matrix. Some notable things come up from time to time (contract writing). In general, if you look at the three criteria that I talked to you about, the (1) technical feasibility, (2) value of the job, and (3) Human aspect. I think that tree should be sufficient. So, in general, that tree should be 3. The criteria should be good enough.

How do you stimulate the shop floor or somewhere else in your organisation to bring up problems or ideas?

We created a problem statement worksheet where every business unit can write their problems. So the initial days, this was good because it highlighted the main problems on the floor; however, with the increasing digitalisation, this strategy started to plateau. It still works today, but this might change in the upcoming few years. Therefore, we are considering tweaking the ideation strategy in the upcoming years.

Interview 7: TUI NL

Date	14-04-2022
Interview Duration	00:30:05
Interview Type	Semi-structured
Location	Online
Interviewee	TUI Netherlands **Confidential**
Reviewed by Interviewee	Yes, on 13-05-2022

How does TUI Fly NL organisation approach innovation?

Within TUI, we have different departments. For instance, for tooling, we have a dedicated tooling innovation team consisting of several people from line maintenance (as they have practical experience and know the needs from an operational perspective. There are also other considerations, apart from operational needs from the managerial side. Hackathons are also organised to generate and select the most promising ideas.

The general way of working is organised as follows. The manager utilized a group discussion to answer questions such as (1) How do you want to proceed? (2) What do you think? Essential to note is that innovation is a combined effort (both the line and office employees). This also improves the support from the line towards innovations, as they can influence decisions.

When considering more considerable innovations, TUI Fly NL coordinates the efforts of the entire TUI group, which could be beneficial because of the size. However, this could also be difficult as significant changes in one part of the group could mean a complete infrastructural change, significantly slowing the process. You have to wait quite a while to make some effort.

Does TUI Fly NL have a matrix or process to assess innovative ideas?

No, this is not in place. It is not a fixed process. However, the feasibility of the idea and the organisational environment is considered. For instance, in Amsterdam, there is no hangar; however, there is one in Brussels, which changes the ideas that are put into practice. For example, 75% of the tooling used in Amsterdam is station-

specific, meaning that we might have a different focus than another station. No matrix is defined as it all comes down to local interaction between the manager and the teams.

Even though there is no matrix, are there predefined criteria to assess ideas?

There are no fixed criteria besides a technical feasibility assessment (often employees from the line) and a background check. Although there are no specific criteria, it is relevant to assess the team's needs and ensure that what is expected by the team is the same as the preliminary business case. One example was the price of dry ice, which was estimated to be four times higher in the business case compared to the actual price. Therefore, a background check is relevant to checking assumptions.

Is there a guideline or budget for innovation?

There is a standard budget for replacements (replacement of tooling). However, approval is required when a new tool or innovation is required. Considerable expenses must be mentioned well in advance, and the management team must approve the expense. For "low" amounts, the manager can approve the expense based on the preliminary business case. The manager can make time for team members to develop the business case around a specific idea. Once an idea moves to the management team, a one-pager is needed to quickly highlight the cost of the idea, the other options, and the backup for operations.

Is there time and money available for general innovations, apart from tooling?

Process innovation can also be applied within workplace instructions, originating from the maintenance organisation exposition (MOE). When the idea arises to change the process, a specialised process team (project development team) is in place to evaluate whether such a change would be possible, considering the other business units within the group.

As an organisation, we believe in pilots to better understand the idea's benefits. Another example is the recycling of clothing, where the supplier of the uniforms presented us with a method of recycling our uniforms. Afterwards, the internal sustainability team was contacted by TUI Fly NL, and the sustainability manager decided to perform a pilot project in the Netherlands.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?

Time would not be an issue within TUI. Our biggest hurdle would be regulators/regulations. For instance, following the Aircraft Maintenance Manual (AMM) instructions, we have to follow the instructions. This can hold us back, especially for simple tools or procedures. Therefore, regulations are critically assessed (according to the MOE) before an idea is further pursued.

Interview 8: Fokker

Date	08-04-2022
Interview Duration	00:48:23
Interview Type	Semi-Structured
Location	Online
Interviewee	GKN-Fokker employee 1 **Confidential**
Reviewed by Interviewee	Yes, on 15-04-2022

How does your organisation approach innovation? (The purpose of the company)

There are two ways to generate ideas (1) customer questions or (2) within the organisation. For instance, when a problem is detected or an opportunity is noticed. This also includes considering opportunities outside the aviation industry. However, new technologies might also be relevant to the aviation industry. For instance, the Hannover Messe (technology expo) is also used to search for potential opportunities outside of aviation.

What processes and tools do you use to preliminary assess innovations to select the most promising ideas?

There is room and opportunity to experiment with different ideas within the technology centre by developing small-scale prototypes and tests. This could also include the involvement of partners.

When the prototype reveals potential, this idea is presented to "Product directors" (responsible for a specific product line, e.g. landing gear). However, before this is presented, it also includes the involvement of marketing, technical, and financial employees to create a clear overview of the actual idea. This meeting aims to present the first draft of the idea and obtain the budget and resources to continue developing the idea and design an actual business case for it. Sometimes ideas are not used for a specific product line but are waiting on the shelf for suitable application. This can also be European projects, including funding.

Employees can contact their production or program managers when ideas arise within the organisation (process improvement, other innovations). Afterwards, the managers contact the technology centre to start the innovation process and concept development. Within this process, the program/production manager is the first assessment to decide whether the idea is pursued or not.

The idea shelf you refer to above, is that a dedicated department?

Yes, the technology departments (spread over multiple locations UK, NL, USA) where multiple people work on particular technologies (e.g. 3D printing). Although there are different locations, they work closely to ensure they are not working in parallel on the same projects. Additionally, when new ideas arise, the technology department checks if any related projects might be relevant to the new idea.

How do you involve employees that proposed the idea?

GKN Fokker tries to involve employees who proposed the idea. For instance, by making them part of the team responsible for developing the idea. They can ask questions and share their views on the project.

Are there fixed criteria to assess innovative ideas or technologies?

We are using the Technology Readiness Level (TRL) process, where they have an evaluation moment when they aim to move to the next TRL level. A fixed set of questions is asked and assessed to determine whether the technology fulfils all requirements. If the technology fails on a few requirements, the team gets a few weeks to fulfil all requirements and usually plans a new evaluation after four weeks.

When looking at existing technologies, ideas are evaluated with the assistance of the program and production managers. The program managers primarily focus on the complete business case (Risks and financial aspects). The production managers are involved as the idea might impact the production process of the layout of the shop floor. GKN often uses small-scale pilots to effectively see the new idea's effect in practice.

How does your organisation test business ideas with limited information or knowledge?

GKN often involves suppliers to demonstrate their technology to understand better how this could help GKN and what the practical implications could be, for instance, a change of IT infrastructure. GKN uses Value Stream Mapping (VSM) to identify the pain points in the process. Therefore, they try to find the non-value-added steps within the process.

What are some crucial aspects and processes when creating an ideation framework based on your experience?

The visibility of the technology centre is essential for idea generation and the overall collaboration between units. For instance, employees from the shop floor are often invited to visit the technology centres to understand what is happening there. This also helps spread the technology centre's existence across the organisation by using mouth-to-mouth of employees and publishing in the GKN internal journal.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems (internal IT, internal business, external third parties)?

Within the technology centres, there is a fixed budget for innovation. I spend 50% of my time on "indirect activities", which cannot be directly assigned to a specific project. However, for the average employee at GKN, 5% of their time can be spent on ‘’indirect activities’’. However, this norm is not highly formalised, and approval from the supervisor is required to spend these hours.

Interview 9: Specto

Date	04-05-2022
Interview Duration	00:59:08
Interview Type	Semi-Structured
Location	Online
Interviewee	Specto employee **Confidential**
Reviewed by Interviewee	Yes, on X

How does your organisation approach innovation? (The purpose of the company)

SPECTO is actively searching for opportunities to innovate and automate internal processes. Some technologies, such as digital twins, 3D printing, and robotics, are utilized to innovate and efficiently organise operations. "When it is not explicitly mentioned it is a hands-on job, we as SPECTO try to use robots to automate the process. However, the aircraft manual remains leading in this process, where we look for opportunities instead of boundaries".

What processes and tools do you use to preliminary assess innovations to select the most promising ideas?

As an SME (small-medium enterprise) organisation, internal communication is relatively easy as the "communication channels" are short. However, this does not guarantee innovative success, as we are also too busy at times with operational matters. We have tried multiple initiatives, such as the idea-collection box. However, we

figured that those boxes and lists are often forgotten or not updated. Therefore, we decided to take a more active approach toward innovation, creating two categories, namely (1) strategic innovation and (2) workplace innovations (low-key and quick fixes). Both types of innovation are not directly connected as they have a separate budget and amount of effort.

The strategic innovations are managed by a team, including three full-time engineers, primarily focused on developing strategic innovations for the MRO. They are entirely separate from production. Although this creates a significant expense for the company, we believe it is essential for the future of SPECTO and our ambition to become an innovative MRO.

Historically speaking, workplace innovations were always tricky to manage. Employees were unaware of how and where to deliver their ideas, and when they deliver an idea, they 'expect' the manager to solve it, minimizing their role. Therefore, we needed a platform to manage ideas and involve employees. Hence, we introduced the CIA (Continuous Improvement Agent). The CIA team is responsible for workplace innovations, where they also manage the introduced ideas from employees. This team aims to introduce and implement at least one improvement each month. They are focused on the "low hanging fruits", typically on innovations that take less than four months to implement.

The CIA team consists of eight members and is a mixture of more experienced engineers and relatively new members, who are often not influenced by the constraints of the industry. However, they all have a technical background (sheet metal, composites, painter, engineer, maintenance manager, and quality manager).

Who is the first point of contact after an employee comes up with an innovative idea?

The first point of contact is the direct supervisor (e.g. maintenance manager), who makes a basic assessment of the idea. However, this assessment is not based on fixed requirements but more on the gut feeling of the supervisors. Some relevant aspects that are considered here are: (1) idea history (have we tried it before), (2) idea relevance (relevant for the business unit), cost and benefits.

Once the supervisor approves the idea, is the CIA the next step?

The complete process is not strictly organised. For instance, sometimes, one of the CIA members is informed about the idea and presents it to the remainder of the team. The process is not highly formalised as the goal was to enhance the innovative throughput. However, we are not mandating employees to follow a fixed pathway with an X number of assessments.

Does Specto have a certain matrix or tool (including criteria) to evaluate ideas?

There is no fixed list of criteria to evaluate ideas; however, specific criteria are informally evaluated. The financial aspect becomes relevant when the budget for innovations runs out.

How does your organisation overcome key challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?

The CIA team is responsible for this process; although there is no fixed mechanism or process in place, they determine which ideas are going to be pursued. The main focus of the CIA Team is to make a success of the combination 'good ideas' and the involvement of personnel.

How does your organisation overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?

For both types of innovation, a fixed budget is predetermined each year. This is both man-hours and actual financial budget, allowing employees to pursue their innovation once the CIA team approves the innovation (without asking for a budget).

When specific targets for innovation per department are implemented, you are creating an artificial environment. We are trying to avoid this and stay close to the natural environment. We want to focus on the group's effort, where we hope that the team will help employees create some spare time to develop their own ideas.

Interview 10: Airbus Scale

Date	13-05-2022
Interview Duration	00:48:23
Interview Type	Semi-Structured
Location	Online
Interviewee	Airbus Employee **Confidential**
Reviewed by Interviewee	Yes, on 08-06-2022

How does your organisation approach innovation? (The purpose of the company)

There are different processes within the innovation ecosystem. One process is called the "Traditional campaign", where ideas are collected from campaign-based (twice a year). As a specific theme could be assigned, a top-down approach is utilised for the campaign's strategy, whilst the ideas follow a more bottom-up approach. Another process is outside-in innovation, where startups present their technology to us, and we are trying to find a suitable application and potential client. The third process is based on the venture client model from BMW, where Airbus invests in start-ups' products to integrate them as quickly as possible.

What criteria and tools do you use to preliminarily assess innovations to select the most promising ideas?

The assessed criteria are (1) idea maturity, where we want to evaluate the location of the idea in the innovation funnel. This criterion is not necessarily a yes/no criterion; however, it is relevant as a starting point to assess the position of the idea. Next, (2) the strategic fit is an essential criterion as it is essential to evaluate it against company strategy and top priorities. Moreover, as part of strategic fit, the fit with the Sustainable development goals (SDG) is necessary and the fit with the Horizon 1,2,3 criterion, as we preferable target H2> for internal ideas. The H1 ideas are not rejected; however, they are redirected to local teams. The following criterion would be the (3) Customer fit, what is the value proposition and how are the pains and gains of customers addressed? Another criterion would be (4) how is it linked with R&D and R&T priorities (roadmaps)? For instance, considering artificial intelligence (AI), how does the proposal fit with the trends and needs. We are also considering (5) the capacity of the idea, How can the idea be scaled? Who will be your external clients? The (6) capacity to finance the idea, where the team is assessing the demand and willingness of the business to invest in the specific idea. Finally, (7) the uniqueness of the proposal is also monitored. At later stages, another criterion is relevant, namely the majority of the solution. A Technology Readiness Level (TRL) process is used to measure this. In summary, there needs to be a budget fit, a problem-solution fit, and a sponsorship fit

How are other criteria, such as technical feasibility or regulatory-fit assessed?

These aspects are embedded within the project management process to develop the solution. When some requirements are not fulfilled in the research phase, it will not enter the acceleration and incubation process. These criteria are assessed throughout the research process, which is before the acceleration and incubation. We are assessing the business model instead of the technology itself at this stage. The solutions examined in the acceleration and incubation process are at least a TRL 4, allowing end-users to tweak the solution. Most of the cases are TRL 6 and above.

How is the financial aspect organised for ideas?

Idea promotors need to find a "sugar daddy" to support and finance their idea; once an idea reaches a given stage where the innovation team believes the idea could scale up, money is invested from the team. Once the business case is demonstrated, there is no limit to it.

Interview 11: Airbus NL

Date	16-05-2022
Interview Duration	00:30:31
Interview Type	Semi-Structured
Location	Online
Interviewee	Airbus NL **Confidential**
Reviewed by Interviewee	Yes, on 17-05-2022

How does your organisation approach innovation?

Airbus NL is focused on space travel and defence and is not directly linked to the aviation division of Airbus. There are two divisions regarding the innovation aspect, namely Innovation and Technology. The first one focuses on the very first aspect of innovation: determining what ideas should be selected from many generated ideas (before any funding). The second division focuses on developing the ideas after the first draft of the business case/business model is defined.

What processes and tools do you use to preliminary assess innovations to select the most promising ideas?

Airbus NL has defined the innovation process as a guideline for innovation on the intranet. However, this can serve as a basis for the process and has some flexibility to it.

There are different ways to fill the innovation funnel/innovation process. (1) Ideas are generated within the organisations; for example, some engineers might generate and develop ideas individually, (2) Ideas could arise in other Airbus business units, partners, or suppliers (3) We are also organising brainstorming sessions based on the current trends in the market (external trend analysis). Some tools that are used throughout this process are: (1) business model canvas, (2) design thinking, (3) customer journey mapping incl persona building

How does your organisation select one (or multiple) out of several ideas?

First of all, it is essential to state that the beliefs of the innovation team could significantly differ from the management's beliefs. The innovator's dilemma book states that a manager is typically assessed on shorter-term results and prefers to minimize risk. Investing in concepts that could radically change an organisation's core business is challenging in such a setting. A balanced portfolio is advised where, e.g. 80% of the investment is for incremental innovation and 20% for next-generation, radically new concepts.

We are creating an overview of our innovation portfolio to manage and select ideas based on their location within the portfolio. Are they Horizon 1,2 or 3? Typically, management teams are aiming more towards H1, whilst the innovation team leans more towards H2/H3. At the same time, we also experience that the required innovation effort to keep your core products competitive (essential for the existence of the organisation) can be underestimated.

We currently use a voting mechanism to select ideas we want to develop further. Each innovation team member had to select their top three ideas and one "red" vote for the least favourable idea. Although it is not formally defined throughout this process, the following criteria are considered. (1) Passion (does it suit the department and the employees? Are they willing to pursue the idea?), (2) Growth potential (does the idea and associated trend have sufficient potential to grow? Looking at the Gartner trend cycle, at what phase is the development?), (3) Available funding, (4) does it fit the capabilities of the organisation, or (5) must-haves (e.g. because of new to-be-implemented regulations or a particular technology/process becomes industry-standard).

On the more practical side of the idea, are these criteria also assessed in terms of technical feasibility or regulations?

This is assessed in the later stages of the process. However, implicitly some aspects are informally assessed on a fundamental level. For instance, some aspects of technical feasibilities can be traced back to (4) the organisation's capabilities. For instance, can we capitalise on this idea from a technical standpoint?

When a few ideas are selected, a business model canvas is utilised to identify to "most critical factors". Some examples are Technical feasibility, customer fit, or attracting the required partners. After each iteration of the business model canvas, these factors might vary. Once determined in the first round, the most critical factors are validated, with the help of a defined test, according to the methodology described in the book "Lean Startup". One example could be interviewing customers to determine the customer need and or fit or building a prototype for a technical check. However, the actual technical feasibility assessment is later in the process.

After a few iterations, the team aims to quantify the case mainly because the financial aspect of the case is relevant to obtaining significant funding for further development. As managers typically examine ROI, required investment, and future earnings.

Based on your experience, are there requirements that need to be evaluated throughout the process?

I would mention two criteria. (1) some innovations require a higher investment than the company can carry. An idea that potentially brings us billions of future revenue sounds great, but it will not fly when it requires hundreds of millions of investments (money isn’t there). Furthermore, (2) the adaptation of ideas within the organisation (problem owner) must be assessed before developing an idea. Developing an idea originating from problems requires less effort than developing from an opportunity.

Who is assessing the ideas before they are implemented within the organisation?

The innovation team is no longer involved from the decision to fund and onwards. The management team (locally Airbus NL) or the international board decides to provide additional funding for an idea.

Interview 12: Air France

Date	30-05-2022
Interview Duration	00:24:23
Interview Type	Semi-Structured
Location	Online
Interviewee	Air France Employee 1
Reviewed by Interviewee	Yes, 23-06-2022

How does X approach innovation? (The purpose of the company)

The MRO Lab is the central body of the innovation ecosystem of Air France. This department is responsible for

They cooperate with innovation leaders across the different business units to pursue innovation. Across the business units, the DIP platform allows employees to submit their ideas on this platform. They can also get a reward for submitting their idea once an idea makes it to the end.

The MRO lab is organised into three main pillars. (1) *Innovation Participative*, (2) *Innovation Collaborative, and* (3) *Innovation Industrielle.* A team of six members are working on the three pillars. The *Innovation Participative* refers to the DIP platform and aims to enhance processes and products on the work floor. The *Innovation Collaborative* is more experimental and includes working with start-ups to apply a technical solution and a proof of concept within AFI. Finally, the *Innovation Industrielle* incorporates a lab where prototypes can be designed and supporting tools can be created to aid the operation. Additionally, external finance possibilities are considered to obtain European funds, subsidies or other revenue streams to cover some of the expenses of innovative projects.

What process and tools does X use to preliminary assess innovations to select the most promising ideas?

Currently, there is no fixed process to assess and/or pursue innovations. The MRO lab aims to support all business units in finding innovative solutions. First of all, they are trying to spend significant time on the work floor to identify and understand the pain points. Secondly, the MRO lab is trying to identify technological opportunities and what might apply to a business unit (What are the technology trends?).

Therefore, the MRO Lab is trying to organise a "first date" for the work floor's technological opportunities and pain points to combine them.

Suppose an idea arises on the floor; how is this communicated with the MRO lab or other departments?

One of our team members is responsible for the communication and animation of the innovation team. The employee goes to the various business units and encourages the communication of ideas to the website of the MRO Lab. A question can be posted through this form and will be answered by the innovation team. Hence, the essential aspect is the visibility and awareness of the existence of the innovation team. Once employees are aware of an innovation team, they can communicate pain points or ideas through the form or directly contact one of the team members.

Additionally, the MRO lab is trying to organise an internal event every month to increase awareness on the work floor and increase the team's visibility. From experience, the innovation team often hears, "I have this idea, but I don’t know how to proceed". The key is communication.

What entails the process of evaluating ideas?

The process is not well defined, and it would be great to have such a process. However, the MRO lab has designed a roadmap for specific themes and projects currently being pursued. This also incorporates themes such as carbon reduction and augmented reality. The MRO lab is trying to identify smaller projects that fit within the more prominent themes.

Currently, the innovation team is trying to pursue many different smaller projects to initiate the innovation process after the COVID-19 crisis. Therefore, the project evaluation is currently pursued ad hoc; however, once the entire ecosystem is set up, it would be beneficial to have an evaluation process.

From your experience, what would be exciting criteria to evaluate when assessing ideas?

Within the MRO lab, we have worked on the way to evaluate innovations. This incorporates criteria to assess which innovation should be pursued. Some relevant criteria are ROI, Operational feasibility, and time to develop.

How does X overcome critical challenges, for example, a lack of time, budget, visibility and internal competition with other innovation ecosystems?

Effectively, the work floor does not have much time to develop ideas. Therefore, the innovation team is trying to contact opportunities and pain points. However, there is room for improvement regarding the budget and lack of time (both the MRO lab and the work floor).

APPENDIX III: CRITERIA DEFINITIONS

This appendix includes a definition of the evaluation criteria either mentioned in the literature or one of the 12 exploratory interviews performed throughout this research.

Category	Keyword	Origin	Definition	Comments
Market	Market Size	Literature	The total number of prospective customers of a service or product within a pre-specified market.	
	Market Growth	Literature, Airbus NL	The (potential) growth rate of total market size.	This criterion also incorporates Growth Potential (Airbus NL)
	Market Share	Literature, Boeing	The fraction of the market is controlled or is expected to be controlled by a service or a product.	This criterion also incorporates Potential Competitors (Boeing Global Services)
	Customer Satisfaction	Literature	The customer's thoughts or feelings towards a product or service.	
	Go-to-market Strategy	Boeing Global Services	The plan to deliver the value of the product or service to the market.	
	Competitive Advantage	Boeing Global Services	The ability to produce products and services superior or cheaper compared to competitors.	
	Customer Need	Boeing Global Services, Airbus Scale	The motivation of a customer to obtain a product or service.	This criterion also incorporates Customer fit (Airbus Scale)
Product/ Process	Strategic Fit	Literature, Boeing Global Services, Haeco ITM, Airbus Scale	The degree to which different organisational activities and strategies are complementary and can co-exist.	This criterion also incorporates Linkages with R&T/R&T priorities (Airbus Scale)
	Usability	JetSupport, ST Engineering	The degree of how well a product or service is able to be used.	
	Product Quality	Literature	The degree of serving the purpose of the product or service, in combination with the industry standards.	
	Degree of Innovation	Literature, Airbus Scale, Airbus NL	The newness of the idea (incorporating the various types of innovation).	This criterion also incorporates Uniqueness (Airbus Scale), and Horizon levels (Airbus NL)
	Definition of the idea's vision	Boeing Global Services	(How clearly defined is the vision of the idea?)	
	Value Proposition	Boeing Global Services, ST Engineering	A statement regarding a product or service to specify the unique selling point / added value for the customer of an idea	
	Product Complexity	Haeco ITM	The degree of difficulty associated with the product or service	
	Product History	Specto	The historical trials or developments regarding the specific idea	
Feasibility	Technical Feasibility	Literature, Epcor, Boeing Global Services, JetSupport, ST Engineering, Tui NL, Fokker, Airbus Scale	The process of ensuring that the idea is technically possible	This criterion also incorporates TRL (Fokker & Airbus Scale)
	Legal Feasibility	Literature, JetSupport	The process of ensuring that the idea is legally possible	
	Operational Feasibility	Epcor, Specto	The process of ensuring that the idea is operationally possible	This criterion also incorporates logistics (St Engineering), and Idea relevance (Specto)
	Financial Feasibility	Epcor, JetSupport, Fokker, Airbus Scale, Airbus NL	The process of ensuring that the idea is financially possible	This criterion is selected when no specific financial measure is mentioned
Compatibility	Existing Infrastructure	Literature	The ability of the idea to be integrated with current infrastructure (IT, current structures, hierarchical)	
	Synergy	Literature, ST Engineering, Airbus NL	The interaction between multiple business units to deliver a combined result, which is greater compared to the separate projects.	This criterion also incorporates Training (ST Engineering) and Fit with organisational capabilities (Airbus NL)
Time	Time to develop idea	Literature, Haeco ITM	The total duration from the idea generation until the development of the business case	This criterion also incorporates Timeline (Haeco ITM)
	Time to market	Literature, Haeco ITM	The total duration from the idea generation until the commercialisation	This criterion also incorporates Timeline (Haeco ITM)
Financial	Cost	Literature, Haeco ITM	The total cost of the idea (e.g. Investment, operating expenses)	
	Profit	Literature	The total profit of the idea (e.g. Direct and Indirect)	
	Return on Investment	Literature, Boeing Global Services, Haeco ITM	The total time required to recuperate the investment	
Other	Ecological Impact	Literature	The effect of the idea on the natural environment (e.g. Biodiversity, Emissions)	
	Acceptance of the workforce	ST Engineering, Airbus NL	The willingness of the employees to work and develop the idea.	This criterion also incorporates Passion (Airbus NL)

APPENDIX IV: EXPERT SURVEY

This appendix presents the design and results of the survey conducted to determine the relevant criteria within the idea evaluation phase within an MRO organisation. The table below presents the participated innovation experts and explains their relevance to this research.

The experts mentioned below are selected based on their roles within a specific MRO organisation. As the four MRO quadrants needed to be present, each category includes three innovation experts. This research used two ways to select the experts. First and foremost, based on the job description, such as Innovation Project & Process Manager, Innovation program lead. The most important aspect is that the job description is directly involved in the innovation and idea evaluation process. Secondly, as typically smaller MRO organisations have innovation as part of another job, they might not have a separate innovation manager. Therefore, related employees were asked for information on whom to approach for the appropriate information regarding the innovation and idea evaluation process. This applies to Epcor, Specto and TUI.

CONFIDENTIAL (TO BE REMOVED IN THE PUBLISHED VERSION)

Respondent	Organisation	Classification MRO	Function
CONFIDENTIAL			

Survey Design

This survey aims to determine the relevance of each of the 28 idea evaluation criteria. Therefore, the following questions were designed to obtain this information.

The survey started with an administrative part where participants were asked to (1) state their name, function and organisation and (2) Would you like to receive a copy of the final thesis? Although this part eliminates the anonymity of the respondents, the researcher needs to verify whether the pre-selected experts have completed the survey. Essential to note is that these first questions are not incorporated in the survey results to ensure and restore respondents' anonymity. Subsequently, the seven categories of criteria (previously defined in section 2.3.3) corresponded to seven questions, each entailing the category-specific criteria.

(3) *What market criterion/criteria are deemed relevant based on your experience?*

- Market Size - The total number of prospective customers of a service or product within a pre-specified market.
- Market Growth - The (potential) growth rate of total market size.
- Market Share - The fraction of the market that is controlled or is expected to be controlled by a service or a product.
- Customer Satisfaction - The customer's thoughts or feelings towards a product or service.
- Go-to-market Strategy - The plan to deliver the product or service's value to the market.
- Competitive Advantage - The ability to produce superior or cheaper products and services than competitors.
- Customer Need - A customer's motivation to obtain a product or service.
- None of the above

(4) What product/process criterion/criteria are deemed relevant based on your experience?

- Strategic Fit - The degree to which different organisational activities and strategies are complementary and can co-exist.
- Usability - The degree of how well a product or service can be used.
- Product/process Quality - The degree of serving the purpose of the product or service, in combination with the industry standards.
- Degree of Innovation - The newness of the idea (incorporating the various types of innovation).
- Definition of the idea's vision - (How clearly defined is the vision of the idea?)
- Value Proposition - A statement regarding a product or service to specify the unique selling point / added value for the customer of an idea
- Product/Process Complexity - The degree of difficulty associated with the product or service
- Product/Process History - The historical trials or developments regarding the specific idea
- None of the above

(5) What feasibility criterion/criteria are deemed relevant based on your experience?

- Technical Feasibility- The process of ensuring that the idea is technically possible
- Legal Feasibility - The process of ensuring that the idea is legally possible
- Operational Feasibility - The process of ensuring that the idea is operationally possible
- Financial Feasibility - The process of ensuring that the idea is financially possible
- None of the above

(6) What compatibility criterion/criteria are deemed relevant based on your experience?

- Existing Infrastructure - The ability of the idea to be integrated with current infrastructure (IT, current structures, hierarchical)
- Synergy - The interaction between multiple business units to deliver a combined result is greater than the separate projects.
- None of the above

(7) What time criterion/criteria are deemed relevant based on your experience?

- Time to develop an idea - The total duration from the idea generation until the development of the business case
- Time to market - The total duration from the idea generation until the commercialisation
- None of the above

(8) What financial criterion/criteria are deemed relevant based on your experience?

- Cost - The total cost of the idea (e.g. Investment, operating expenses)
- Profit - The total profit of the idea (e.g. Direct and Indirect)
- Return on Investment- The total time required to recuperate the investment
- None of the above

(9) What other criterion/criteria are deemed relevant based on your experience?

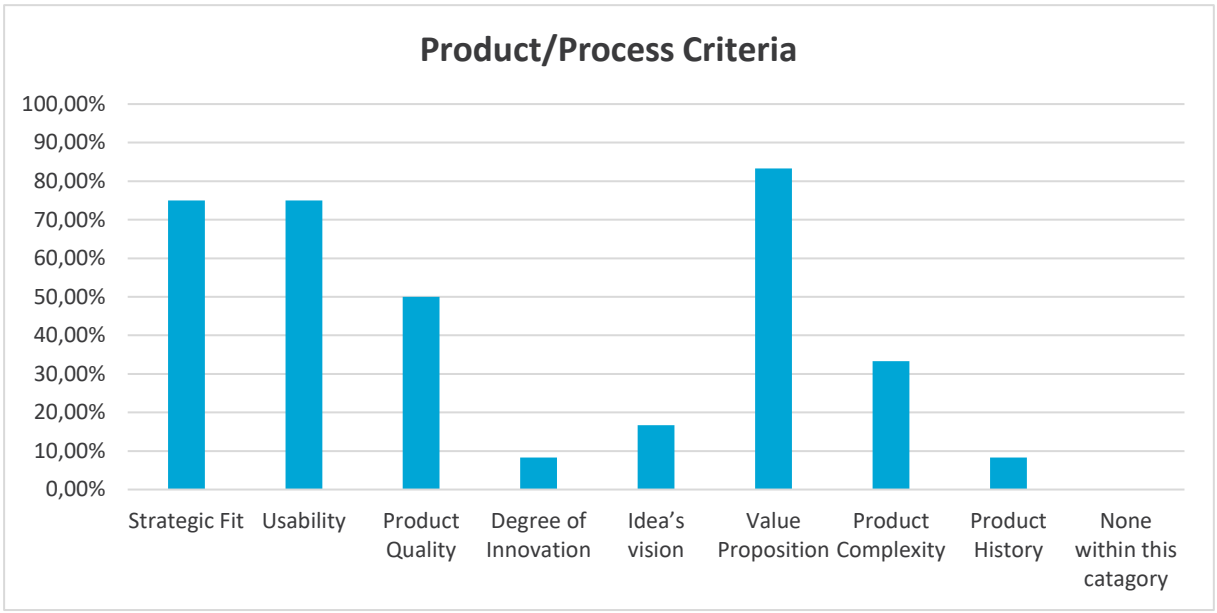
- Ecological Impact - The effect of the idea on the natural environment (e.g. Biodiversity, Emissions)
- Acceptance of the workforce - The willingness of the employees to work and develop the idea.
- None of the above

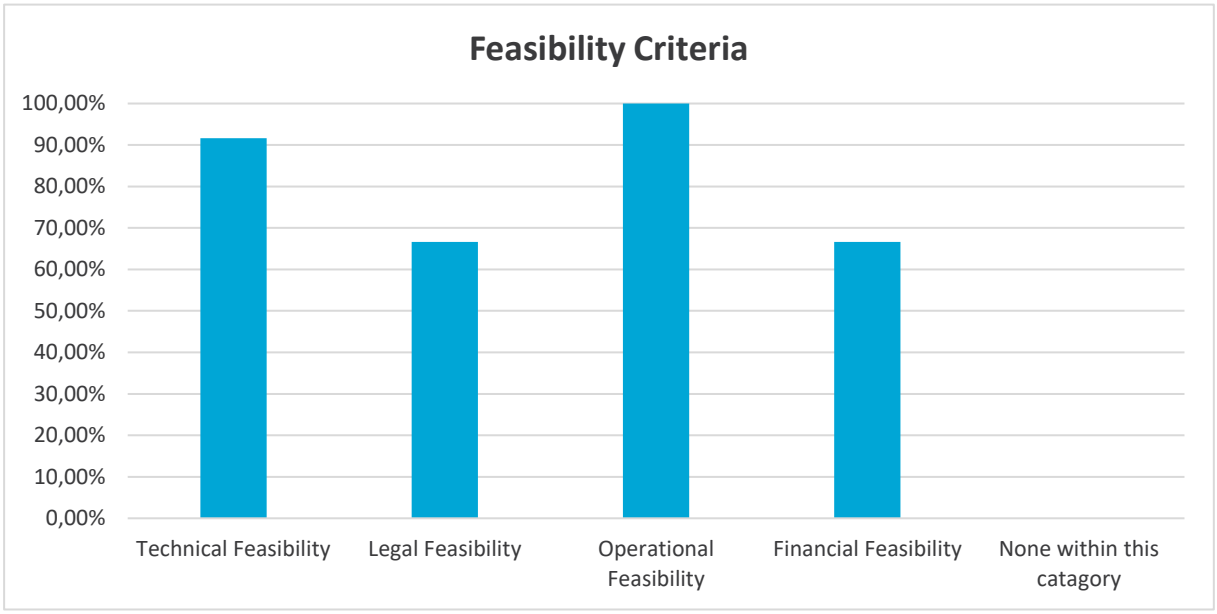
After the respondents had selected the relevant criteria for the idea evaluation process based on their experience, it was essential to prioritise them (10). As the idea evaluation framework includes a two-step evaluation process, it is essential to evaluate the highly relevant criteria in the first evaluation moment to avoid any apparent failures. Therefore, this question could aid the first evaluation moment.

As a final check, respondents were asked to add any evaluation criteria not mentioned, which are also relevant based on their experience (11). This question aims to ensure that all relevant criteria are taken into account.

Survey Results

As mentioned above, the 28 criteria are divided into seven categories. The expert survey created the following results per category. The figures are presented below to visualise the percentage of the total voters who selected specific criteria. For instance, if 12 experts (out of 12) selected a specific criterion, 100% of the experts deem this criterion as relevant to evaluate.


Product/Process Criteria
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Strategic Fit
Usability
Product Quality
Degree of Innovation
Idea's vision
Value Proposition
Product Complexity
Product History
None within this catagory


Feasibility Criteria
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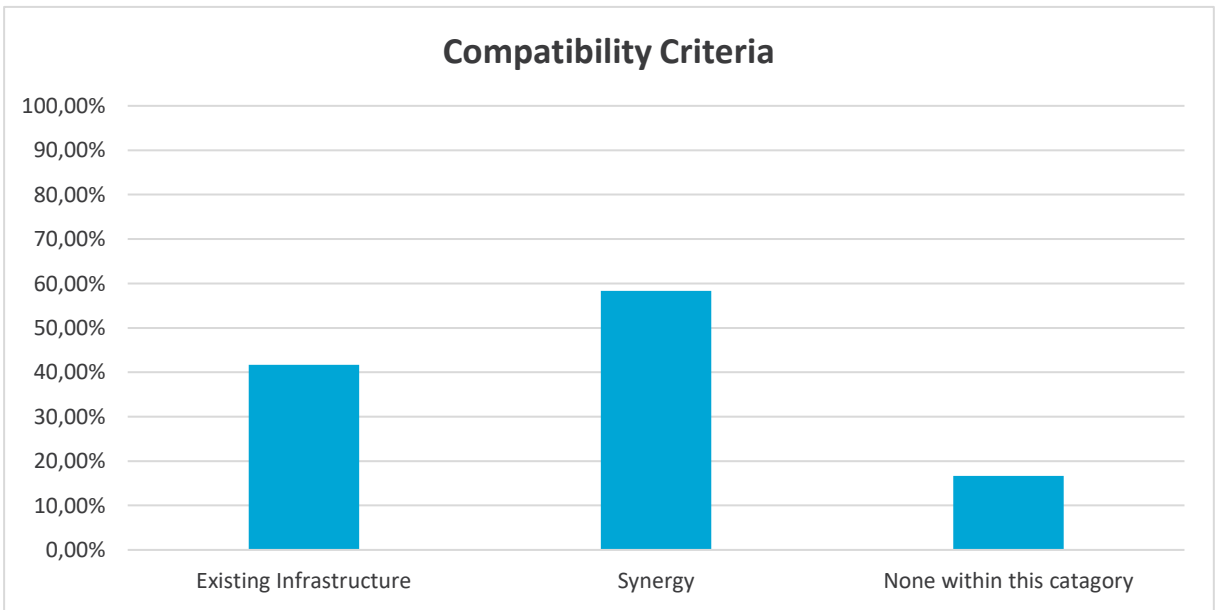
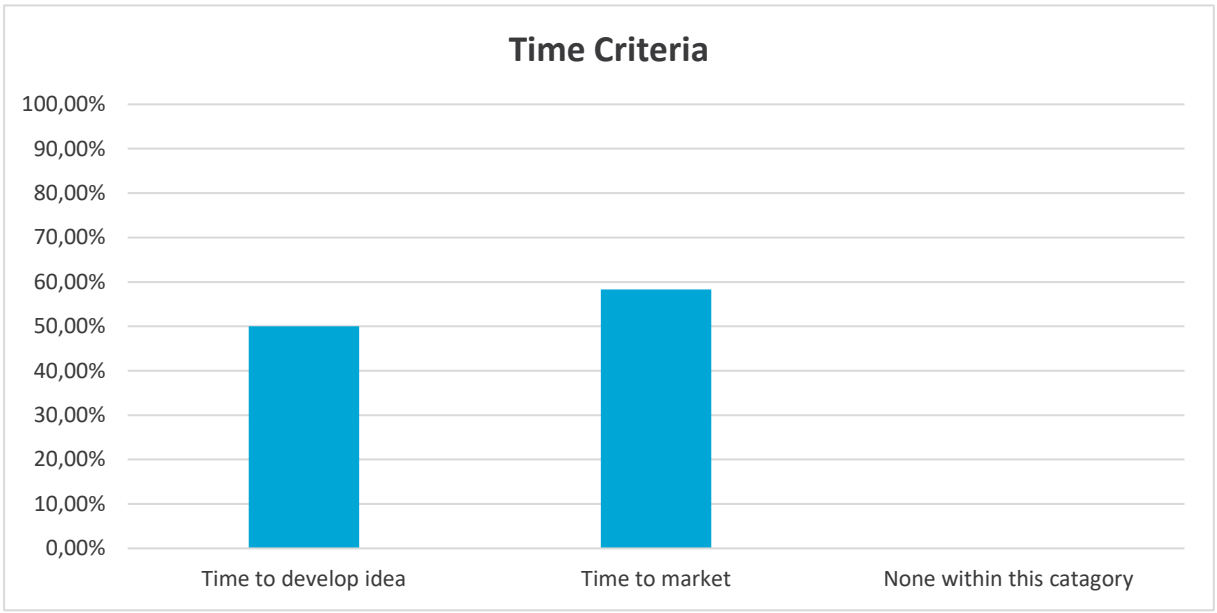
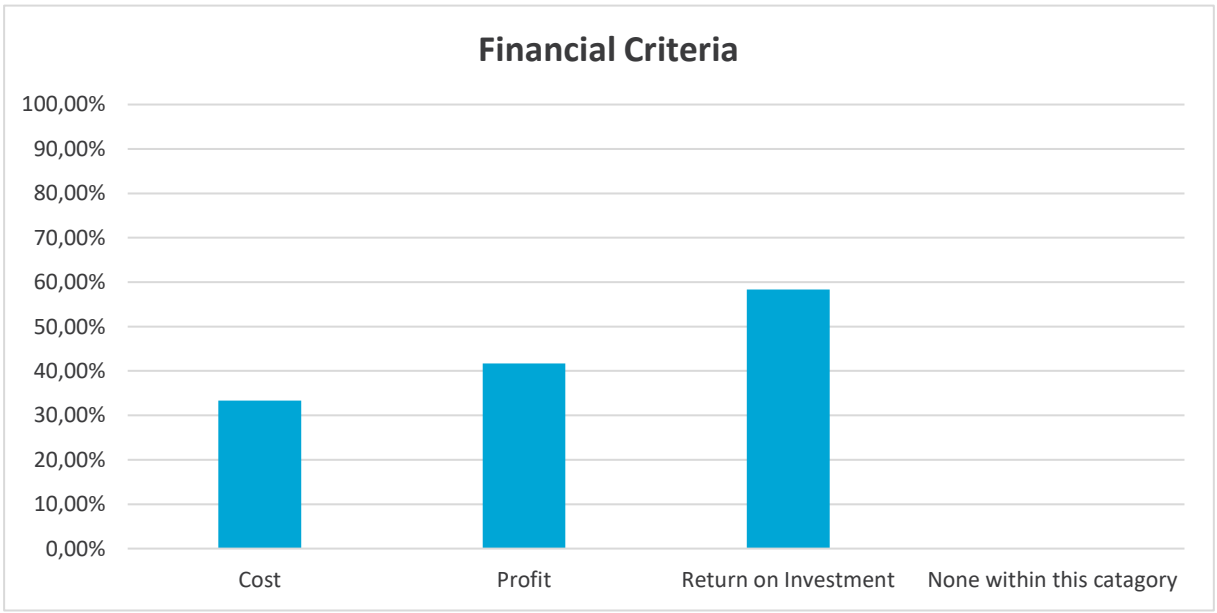
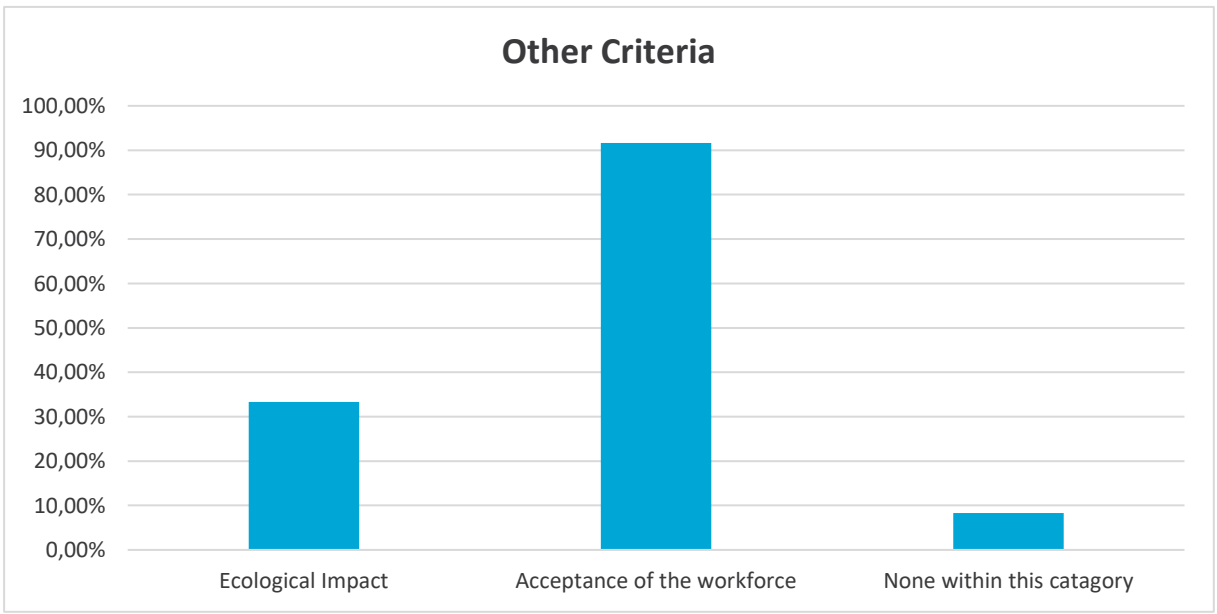
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Technical Feasibility
Legal Feasibility
Operational Feasibility
Financial Feasibility
None within this catagory


Compatibility Criteria
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Existing Infrastructure
Synergy
None within this catagory


Time Criteria
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Time to develop idea
Time to market
None within this catagory


Financial Criteria
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Cost
Profit
Return on Investment
None within this catagory


Other Criteria
100,00%
90,00%
80,00%
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
Ecological Impact
Acceptance of the workforce
None within this catagory

The survey results provide vital information for determining the evaluation criteria throughout the front-end evaluation process. Based on the above percentages, a criterion mentioned by more than 50% of the MRO experts is deemed relevant for the idea evaluation framework. Therefore, the following criteria are relevant for designing an idea evaluation process for the Aviation MRO.

Category	Keyword	Percentage of total respondents
Market	Customer Satisfaction	75,00%
	Competitive Advantage	66,67%
	Customer Need	66,67%
Product/ Process	Strategic Fit	75,00%
	Usability	75,00%
	Value Proposition	83,33%
Feasibility	Technical Feasibility	91,67%
	Legal Feasibility	66,67%
	Operational Feasibility	100,00%
	Financial Feasibility	66,67%
Compatibility	Synergy	58,33%
Time	Time to market	58,33%
Financial	Return on Investment	58,33%
Other	Acceptance of the workforce	91,67%

Additionally, The MRO experts were also asked whether any criteria were missing. This question aimed to ensure that all relevant criteria were considered in this research. One additional criterion was mentioned by one expert, named "Brand Reputation". This criterion aims to contribute to the exposure of the MRO firm as a technology company. Nevertheless, this criterion is not mentioned in any reviewed literature or by the remaining eleven experts. This criterion is not considered vital for the foundation of the framework designed in this research.

Finally, the 12 MRO experts were asked to prioritise the top 5 of all criteria from the seven categories defined within the survey. This is presented in the table below, where 1 is the most critical criterion. These final questions aim to aid the researcher in determining the relative importance to the criteria compared to one another. Note: One respondent did not fill in this question.

To determine the most critical criteria, points are assigned to the criteria ranking to determine the average score of the twelve interviewed experts. As a calculation example, one can consider expert 1. As top priority *Customer Needs* is rewarded with five points, *Value Proposition* (four points), *Strategic fit* (Three points), *Usability* (Two points), and *Synergy* (one point). Afterwards, the average top five classifications is created based upon the combined opinion of experts. This resulted in the following results, as presented in the table below.

Combined top 5 criteria	
Criteria	Points
Strategic Fit	31
Customer Need	16
Value Proposition	16
Return on Investment	14
Acceptance of the Workforce	14

APPENDIX V: CASE STUDY INTERVIEWS

The interviews used to understand the innovation process (focused on the idea evaluation aspect) are documented and transcribed in this appendix. Important to note is that interviewees are de-identified to ensure that any personally identifiable data is removed from the interview transcripts. This will guarantee the confidentiality of employees that agreed to cooperate with this case study.

As the interviews in this appendix are used to understand the innovation and innovation ecosystem within KLM E&M, the interviews are unstructured. Although a limited number of questions will be prepared in advance, the primary purpose is to enhance the understanding by responding to interviewees' answers. This report uses the edited transcription style (Scribbr, 2022), as this provides the ability to create "Filter" the relevant concept during the interview. However, the edited transcription style could change the meaning of sentences, as the interviewer could misinterpret information. Therefore, the edited transcription is sent back to the interviewee to confirm that the interview context remains consistent and that any misinterpretation can be rectified.

Subsequently, focus groups in the form of expert panels were organised to apply the proposed framework within the organisational boundaries of KLM E&M. Three expert groups were organised, each serving a specific goal.

Expert group one: This expert panel aimed to design the initial screen (first evaluation moment) by applying the proposed framework within the organisational boundaries of KLM KLM E&M. This expert group consisted of two KLM E&M employees. Firstly, the Innovation Project & Process Manager understands the pain points in the current process and can contribute to this panel by sharing his experience and known needs on how to evaluate ideas. Secondly, a Continuous improvement lead[4] is in close contact with the operational environment, meaning they are aware of the needs and issues on the shop floor, which is essential to consider throughout the initial screen.

Expert group two: This panel intended to create the preliminary evaluation (Second evaluation) within the organisational boundaries of KLM E&M. The six attendees consisted of the Innovation Project & Process Manager, Blackbelts, and Continuous improvement leads. They all have experience with pursuing innovative ideas within the organisation and are often involved in internal challenges to evaluate and select ideas.

Expert group three: This final expert panel intends to design the complete idea evaluation process based on the findings of the first two expert panels and this research study. The previous expert pannels were used to detect the appropriate criteria for the initial screen and the preliminary evaluation. Hence, this final expert panel could be used to design the process and assign appropriate employees to the evaluation moments

[4] Responsible for improving work processes in close collaboration with the operational environment.

Interview 1: Innovation Project & Process Manager

Date	24-03-2022
Interview Duration	00:44:50
Interview Type	Unstructured Interview
Location	Schiphol – East
Interviewee	Innovation Project & Process Manager
Reviewed by Interviewee	Yes, on 29-03-2022

When considering innovation and sustainability, KLM has an overarching Strategy/Transformation office responsible for determining the complete and central strategy. Therefore, the general direction and the goals of the organization are determined in the Transformation office.

Historically, innovations were tested and afterwards spread through the organization. However, COVID-19 has disrupted innovation within KLM. For instance, the Digital studio no longer exists within KLM. Within this department, new platforms and innovations, such as AR and VR, were tested to assess the added value of these technologies for KLM.

Before COVID-19, the three innovative units were Plant X (Stopped), digitizing (restructures within other organizational units), and the MRO Lab still exists (although it is reduced in size). The Improvement café (meeting every three weeks) and champion meeting (every month) are also on hold.

However, KLM is organizing a sustainable challenge to promote the creation of a more sustainable working environment, where every employee can critically assess their working environment and submit ideas for sustainable practices. Afterwards, the most viable ideas will be selected, of which ten can develop into a business case. Subsequently, E&M employees can vote for their ideas, and they, together with a selected jury, will determine one or multiple winning ideas, which are put into practice.

How did KLM select and assess the feasibility of the ideas in the challenge, as this is closely related to the idea evaluation process?

The organisation of the challenge asked the sustainability lead of a specific department to assess the feasibility (together with their team) of the ideas associated with their department. Therefore, using 25 sustainability leads (employees) and their network within the organisation. Before this process, five challenge organisers assessed the ideas to filter ideas which were not feasible due to fixed restrictions, such as regulations.

The current process of idea evaluation depends on the ‘known’ networks and connections within the organisation. When someone enters the MRO lab, they primarily use their network across KLM to connect the idea with other departments or initiatives.

Pre-COVID, when a promising idea is discovered, the MRO lab could assist in creating a presentation that is presented to various vice presidents (VP) across the KLM E&M organisation. When the management approves the idea, a proof of concept can be created. However, this process is already after creating a business case and is not the idea-evaluation process. The main problem discovered during this phase is the financial uncertainty of innovations directly related to the feasibility of ideas. The ideal scenario would be dedicated financial resources

that can be used for experimentation without needing a very sophisticated and detailed business plan. Another problem identified is that shop employees cannot register their ours on innovation. They need to state them as ‘’unproductive hours’’ in the system.

Question: What would be your preferred process, and what do you think is needed to improve the innovation process, including idea evaluation?

I am in favour of having a separate budget for innovation to avoid the need to search for resources across the organisation constantly. Employees need to know how to find you, and what they can expect from you. Additionally, the innovation and sustainability council (added by nearly all VPs) is currently used to obtain a budget for innovation. However, I would not change the process itself.

Question: Assuming KLM E&M obtains an unconstrained budget, how are you planning to separate promising and less promising ideas, assuming you will not use VPs for this?

I am convinced that the MRO lab, and network, would be able to create a preliminary selection. However, this is currently not in place and is not yet necessary with the limited number of ideas.

Question: Do you think the characteristics of the aviation industry are hindering the innovation process as a whole? If yes, what characteristics?

KLM Specific: (1) Employees that are already very long within the organisation and often also in the same position, (2) the ‘’We cannot do it because’’ culture, (3) in aviation in general, the regulations are offering exceptions for the aviation industry.

Regulations make it more difficult to innovate, and often some innovations are technically feasible; however, they are only limited by regulations.

Fleet utilisation is one of the key performance indicators that drive the operation. In the operational environment, "An aircraft in the air will pay the bills, an aircraft on the ground will not". Therefore, there is minimal time to work with aircraft; for instance, mapping the aircraft with drones takes six months.

Interview 2: Continuous Improvement Lead

Date	28-03-2022
Interview Duration	00:38:31
Interview Type	Unstructured
Location	Schiphol – East
Interviewee	Continuous Improvement Lead
Reviewed by Interviewee	Yes, on 29-03-2022

Within the hangar, there is an innovation council every two weeks, where maintenance personnel can share ideas to improve their current way of working. Besides maintenance employees, multiple support staff (including the continuous improvement lead) are attending the council to listen to new potential ideas. When a new idea arises, the process of evaluating and assessing this idea is currently unstructured/not in place and depends on the connections of members of the innovation council to find support and resources across the organisation to develop the idea into a business case. Therefore, KLM E&M could benefit from a more structured and centralised location and process, which would make it easier to develop ideas into projects. Additionally, this makes it more transparent

and rewarding for employees to share their ideas as they are more involved and aware of the idea evaluation process instead of having no clue why their ideas are not supported or implemented.

Apart from innovating within each unit, such a centralised process can also help the department share ideas from another location or department. This would allow departments to learn from each other. It would also be beneficial to consider internal ideas and learn from companies and partners that might originate from a completely different industry. This could also help employees start thinking more ‘’outside the box’’.

Expert group 1: Initial Screen

Date	08-06-2022
Interview Duration	00:57:56
Interview Type	Expert Group
Purpose of the interview	Apply the proposed framework within the organisational boundaries of KLM. The result should be the basis for the checklist of the initial screen
Location	Schiphol-East
Interviewee	Innovation Project & Process Manager & Continuous Improvement Lead

At the beginning of this expert panel, the proposed framework was presented to both attendees, incorporating the criteria proposed by the literature. Additionally, the goal of the meeting was presented to ensure the experts understood the purpose of this panel. The expert survey, as presented in Appendix IV: Expert Survey, is used to determine the relevant criteria within the initial screen. The two main aspects of this expert panel are (1) who will perform the initial screening and (2) what criteria should be included. The following abbreviations are used below CIL: Continuous Improvement Agent and IPP: Innovation Project & Process Manager

Who will perform the initial screening?

CIL: I would present the checklist to the employees on the work floor to ensure they know how their ideas will be assessed. This also means they are also to assess their ideas before submitting them. Afterwards, they can discuss the checklist with the CIL to share their thoughts and adjust the checklist based on the experience of the CIL.

What criteria should be included in the initial screening?

Acceptance of the workforce and customer needs

CIL: For all ideas, it is essential to test the willingness and acceptance of the workforce to work with the new idea. Is there an actual broader need apart from the initiator of the idea? How is the impacted workforce responding?

IPP: I also think workforce acceptance is essential to evaluate. Another aspect would be whether the idea is aligned with the customer's needs. "We often think that one needs an innovation; however, it frequently turns out to be a wrong assumption. Therefore, we need to assess if we are pursuing ideas because of an actual need and not because we think it is necessary".

Idea duration

CIL: Based on experience, it can also happen that the customer needs change over time. Especially when the implementation has a significant duration. This could mean that the main reason for pursuing the idea has changed or is vanished in the meantime. For instance, the idea is to reduce the complexity of a system; however, all employees have learned to work with the product in the meantime. Therefore, the need for a new product or innovation has significantly reduced. Therefore, assessing the idea's duration could also be relevant.

Strategic fit

CIL: The strategic fit is challenging to assess together with the workforce. It makes sense for top-down innovations as they are aware of the organisation's strategic objectives. However, the workforce is mainly focused on their day-to-day operation and is often unaware of the overall and unit-specific strategic objectives. Therefore, they would be unable to answer this question in the checklist. Alternatively, this question can be answered with the CIL; however, you are already starting to research the idea in more detail and contacting other relevant stakeholders. This should be done after the initial screen.

IPP: I think the strategic fit is associated with the prioritisation of the idea. For instance, when multiple ideas are approved in the initial screen, the second evaluation can prioritise them based on the impact on the strategic objective. As the workforce has limited knowledge of this aspect, you don't want to discourage them from putting forward new ideas.

CIL: The strategic fit could be relevant for small to medium enterprises, where the direction and strategic objective are more evident to the workforce. However, it is tricky to assess within the initial screen at KLM. Currently, idea generation is limited; however, introducing very complicated questions is not aid in generating ideas. You don't want to kill the ideas early and discourage the workforce.

Value proposition

CIL: Within the value proposition, it would be beneficial to have separate categories classifying the problem at hand. Is this idea addressing regulations, financial, or operational issues? Afterwards, the value proposition should include information on how the problem is going to be addressed by the idea. By designing the various categories, we could prevent the employees on the shop floor from focussing on the financial aspect, for instance.

Synergy

CIL: When the knowledge regarding other related projects is aivalible on the shop floor, it is very beneficial. However, the knowledge is very rarely aivalible there. Although some employees are associated with various projects and therefore have some know-how, this is often not the case.

IPP: Maybe when we inspire the employees enough, they might recognise opportunities within other projects. For instance, finding other applications for drones currently used for visual inspections.

CIL: It is good to ask for related projects and or opportunities that are spotted on the work floor. However, we should not assess ideas based on the completeness of this criterion as they can not always answer this aspect. Therefore, it could potentially be integrated into the value proposition.

Financial feasibility

IPP: For instance, aircraft cleaners would be unable to estimate the total cost of a project to incorporate robots to aid their operation. It would be unrealistic and demotivating to ask them to perform financial estimations.

CIL: When helping them with the estimation, you are performing the explorative phase between the two evaluation moments. Therefore, financials are relevant in the second assessment and not necessarily in the first one.

Additionally, some ideas will never make a (Short-term) positive ROI or are an enabler for another technology. When all ideas are assessed based on strict financial requirements, this also kills potential ideas in a very early stage.

The newness of the innovation

CIL: When an idea is classified to be "radical" and very out of the scope of the day-to-day operation. There needs to be a different way of assessing those ideas. The duration is usually very long, incorporating high financial costs; however, it is also an opportunity that you don't want to miss an organisation.

At the end of the meeting, it was concluded that (1) customer need, (2) acceptance of the workforce. (3) Time to implement, (4) Value proposition (including categories), and (5) the newness of the innovation are relevant to assess during the initial screen.

Expert group 2: Preliminary Evaluation

Date	28-04-2022
Interview Duration	01:58
Interview Type	Expert Group
Purpose of the interview	Apply the proposed framework within the organisational boundaries of KLM. The result should be the basis for the Weighted score matrix within the preliminary evaluation.
Location	Schiphol-East
Interviewee	Innovation Project & Process Manager, Continuous Improvement Lead, and blackbelts

This expert group aimed to complete the following aspects: (1) Determine the criteria relevant to evaluate. (2) Determine the weight of each criterion relevant to each other, and (3) determine the scale of the criteria to determine the overall score.

Relevant Criteria

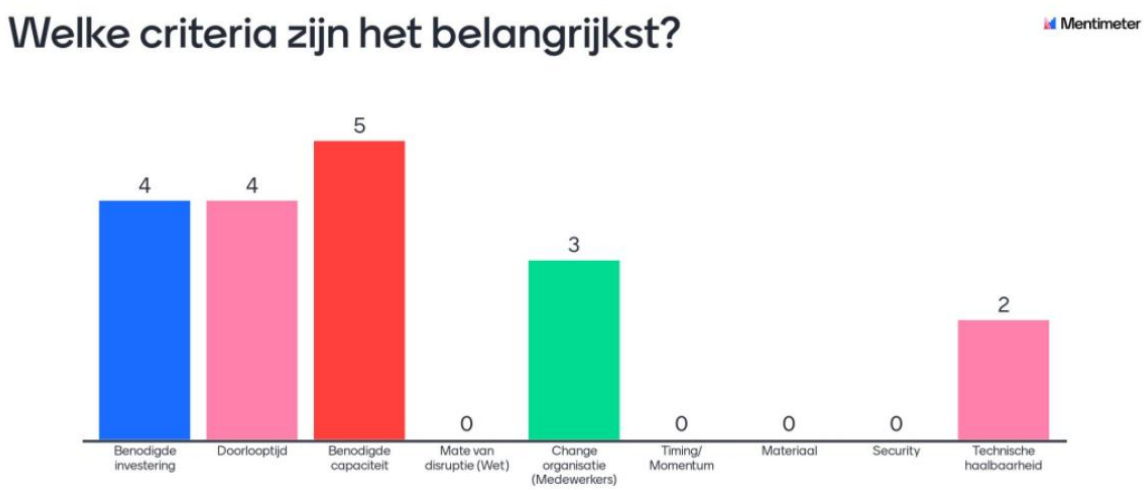
To determine the 1-2-4-All methodology is utilised to focus on both individual and collective intelligence (Klaxoon, 2022). This method includes multiple rounds to determine the relevant idea evaluation criteria. The methodology is adjusted (the round incorporating four is removed) as only six attendees were present in the meeting.

- *Round 1 (Solo):* All attendees individually write down criteria they feel are relevant to assess.
- *Round 2 (in pairs):* All attendees are divided into pairs and collectively examine their answers to remove doubles or consider additional evaluation criteria.
- *Round 3 (All):* the facilitator asks the entire group to present the results and highlight the shared criteria. At the end of this round, a complete list of idea evaluation criteria is presented.

This methodology resulted in the following criteria that were deemed relevant by the six attendees:

- Required investment
- Total duration
- Degree of disruption
- Organisational Change
- Timing / Momentum
- Material
- Security
- Technical feasibility

Subsequently, all attendees were granted three votes to determine which criteria were deemed relevant to assess. As a result, five criteria were deemed relevant to capitalise upon during the preliminary evaluation.

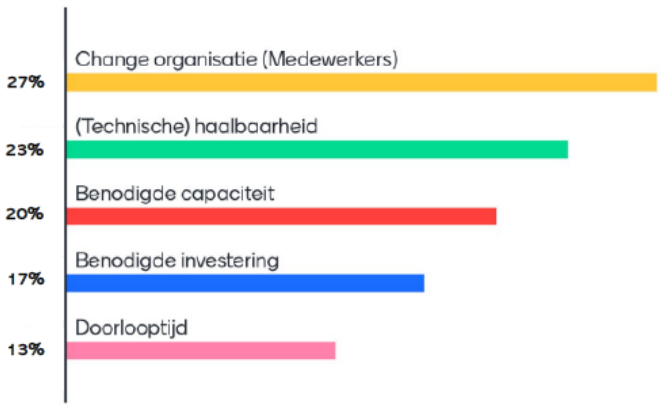


Afterwards, the criteria of the meeting were compared to the criteria defined by the idea evaluation framework to ensure all the criteria were considered before continuing to the next phase. The group concluded that some criteria could be merged, and shared definitions could be created to cover multiple closely related criteria. This resulted in the following list of criteria. When comparing the initial criteria with the framework, some changes were performed to create a more comprehensive evaluation. For instance, technical feasibility is changed into feasibility in general also to incorporate regulations, safety, security etc.

Criteria	Definition
Organisational Change	The amount of expected resistance within the organisation is determined by the combination of the (1) Size of the impacted group and (2) The amount of resistance expected per individual (top-down or bottom-up).
Feasibility	The state or degree of being quickly or conveniently done. Relevant aspects include Technical, Safety, Security, IT, Management support and Regulations.
Required Capacity	The number of manhours that are required to implement the project.
Required Investment	The amount of financial investment that is required to implement the project
Project Duration	The amount of time it takes to implement the project

Weighing the criteria

After the criteria were determined, a weight had to be assigned to determine the relevance of each criterion compared to the others. Therefore, all attendees were assigned 100 points, which they could divide over the five criteria. The assigned weights can be observed in the figure below.



Determine the scales of the criteria

After determining the weight of each criterion, the scoring scale had to be determined in order to complete the evaluation matrix. The following scales were deemed applicable by the six attendees.

Criteria		Score				
Category	Explanation	1	2	3	4	5
Organisational Change	The amount of expected resistance within the organisation is determined by the combination of the (1) Size of the impacted group and (2) The amount of resistance expected per inidvidual (top-down or botom-up).	Nil	Slight	Average	Large	Major
Feasibility	The state or degree of being easily or conveniently done. Relevent aspects include: Technical, Safety, Security, IT, Management support and Regulations.	Very high	High	Average	Low	Very Low
Required Capacity	The amount of manhours that are required to implement the project.	<40	40-500	500-1.500	1.500-5.000	5.000>
Required Investment	The amount of financial investment that is required to implement the project	<15.000	15.000 - 500.000	500.000 - 5mln	5 mln - 25 mln	>25 mln
Project Duration	The amount of time it takes to implement the project	< 1 month	1 month - 3 months	3 months- 6 months	6 months- 1,5 year	>1,5 year

Expert group 3: Process Review

Date	15-06-2022
Interview Duration	00:45:41
Interview Type	Expert Group
Purpose of the interview	Apply the proposed framework within the organisational boundaries of KLM. The result should be the overall structure of the process within KLM E&M.
Location	Schiphol-East
Interviewee	Innovation Project & Process Manager, Continuous Improvement Lead, blackbelt, and Program Lead Innovation & Sustainability

The Idea evaluation process consists of two evaluation moments. However, other supporting systems are also necessary to ensure the process works correctly.

For instance, when designing a process for the workforce to upload their idea, the system should support their needs and wants. This should ensure they are willing and can support ideas and evaluate them together with a continuous improvement lead (CIL) or blackbelt. The idea submitter should be included to explain their idea, as this would be difficult to grasp from a piece of paper.

The second evaluation should be geared towards evaluating ideas based on factual information. Throughout the idea research phase, information is validated and obtained to allow the second evaluation to be as objective as possible. However, uncertainty will remain as this does not include creating a business case.

When an idea is submitted, how can we start the process?

The idea submission should be as accessible as allowing employees to fill in their idea without needing external assistance from the blackbelt of the CIL. Through the idea submission, a few questions can be asked to obtain information, although they should not be mandatory. Some questions could be:

1. Is the idea applicable to your department?
2. Do you think the idea is also applicable to another department? If yes, which one?
3. What will result from the idea (Reduce costs, enhance sustainability)?
4. What problem/opportunity is exploited by implementing the idea?
5. Is this a unique idea or a group submission?
6. What do you think will be the required investment?

7. What do you think will be the duration of implementation?
8. Have you seen the idea before? (Within KLM or external)

Subsequently, the CIL or the Blackbelt should go to the idea submitter to complete the remaining questions and complete the overall view of the idea. This aspect depends on the completeness of the previous step; however, not all employees might have the expertise to complete the predetermined questions. Afterwards, the CIL evaluates the idea based on the defined criteria from the initial screen and identifies the potential pain points. These pain points should be reviewed during the idea research phase to gather more information before the idea can be assessed within the preliminary evaluation. The idea research phase includes incorporating Subject Matter Experts (SME) to obtain the required information.

APPENDIX VI: EVALUATED IDEAS

Four ideas were selected to be evaluated during this research. As the projects need to be compared, the projects need to impact the same sustainability target. Therefore, waste is selected as the specific topic for the ideas. The projects elaborated below are identified and incorporated within the enhanced version of the E&M roadmap.

Idea 1 – Vendor arrangements for sustainable packaging

By defining agreements with vendors regarding sustainable packaging, the overall entry of waste is reduced. This also eliminates the necessity to launch projects to recycle the packaging. Therefore, this idea is classified as a four on the impact scale. As the internal procedures are likely to remain relatively similar, the resistance is estimated to be slight. Next, the feasibility (regulatory, management support) is classified as low, as the packaging is highly regulated and incorporates significant changes. Finally, the idea is expected to require 1500-5000 person-hours, 500.000-5 million, and takes at least 1.5 years to implement (Effort 3.4).

Idea 2 – An employee awareness campaign

By increasing the awareness among employees, especially the awareness of the KLM Sustainability goals, the behaviour of employees might be altered (Impact 4). As this requires additional effort from the employees, average resistance is expected. The highly feasible campaign is expected to require 40-500 person-hours to initiate, incorporating a small investment of <€15.000. lastly, as behavioural changes take time, the duration is estimated to be 6-18 months (Effort 2.4).

Idea 3 – Stop single-use cups

This idea is repeatedly shared across the whole organisation as plastic pollution is evident to all employees. Although eliminating plastic cups is a drop in the ocean, this is likely to increase the employees' awareness (Impact 2). However, resistance is expected to occur as employees need to organise alternatives. Additionally, the feasibility is classified as very high (not adding new plastic cups). Next, the required capacity is estimated to be within 40-500 manours, and the investment is not expected to exceed €15.000. The total duration should be less than a month (Effort 1.8).

Idea 4 – Update the SAP system to prevent unnecessary printing

KLM E&M utilised SAP for inventory management, among others. As this is organisational-wide, estimated to be above 10.000 kg on an annual basis. This idea receives an impact score of 3. As the procedures remain equal, minimal resistance is expected. However, legal regulations must be evaluated before altering the SAP system. This extensive collaboration between KLM E&M and SAP will likely cost between 500-1500 person-hours, €15.000-500.000, and take between 3-6 months (Effort 2.3).